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ABSTRACT

This second volume of a comprehensive curriculum guide for the heating-ventilation-air conditioning-refrigeration-solar student is designed to assist high school area vocational centers or community college instructors in the implementation and operation of comfort training programs. The guide is comprised of ten units of instruction within three areas: refrigeration theory, refrigeration service procedures, and heat-transfer methods and systems. Presented for each unit are unit numbers, instructional objective, reference materials, audio visual materials available, outline, performance conditions, student evaluation criteria, procedure of instituting unit, unit tests, and exams. (LRA)

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SOLAR ENERGY INSTALLERS CURRICULUM GUIDES
BOOK II

U.S. DEPARTMENT OF HEALTH
EDUCATION & WELFARE
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AREA - REFRIGERATION THEORY

Unit 19 - Introduction to Reciprocating Compression

I. Instructional Objectives
To familiarize students with the four main components that make up the refrigeration system. Show students how various undesirable conditions can effect the overall efficiency of a refrigeration system. To demonstrate service and design procedures, which will help improve overall system operation. To provide a working knowledge of reciprocating compressors.

II. Reference Materials
Trane Air Condition Manual - 6
Basic Air Conditioning, 10, 11, 12, 13
Principles of Refrigeration, 6, 7, 8, 9, 10, 11, 12, 13, 14

III. Visual Aids
Overheads of Pressure-Enthalpy Charts

IV. Method Performance Conditions
Student will be given P.H. Charts to work out problems on.

V. Outline

1. Review of mechanical refrigeration cycle.
2. Properties of refrigerant.
3. Gas laws.
4. Pressure - enthalpy relationships.
5. Efficiencies of the compressor.
6. Effect of subcooling and superheating refrigerants.
7. Power requirements of compressors.
8. Lubrication and valves.
9. Compressor unloaders.
10. Metering devices
11. Line sizing
12. General problem solving

VI. Student Evaluation Parameters

Student will demonstrate a knowledge of the reciprocating refrigeration cycle through drawings of systems. Student will work through use of the pressure enthalpy charts both 12 and 22, showing systems in different service problem conditions.

VII. Sequence of Instruction

1. Read all reference materials.
2. Do questions and problems at end of chapters.
3. Work through problems on overheads.
4. Do sample refrigeration cycle plotting.
5. Take unit tests.

Unit 19 - Quiz #1

Name_____

ALL WORK MUST BE SHOWN TO RECEIVE FULL CREDIT.

1) Given an evaporation temperature of -5°. A condensor temperature of 115°. Th's being A R12 system.

Find the increase in refrigerating capacity if the liquid was subcooled to 80°F.

2) With gauge readings of 310# and 72# and liquid reaching the expansion valve 10° colder then it condenses at.

Given a Compressor with 6 cylinders abore of 2.25 and a 2.50 stroke, running at 1750 RPM and using R22 refrigerant. Find the following:

a) capacity of the compressor, actual
b) capacity of the compressor, theoretical
c) pounds at vapor per minute
d) total piston displacement
e) compression ratio
f) theoretical weight of refrigerant pumped
g) vapor density
h) volumetric efficiency
i) actual weight of refrigerant pumped

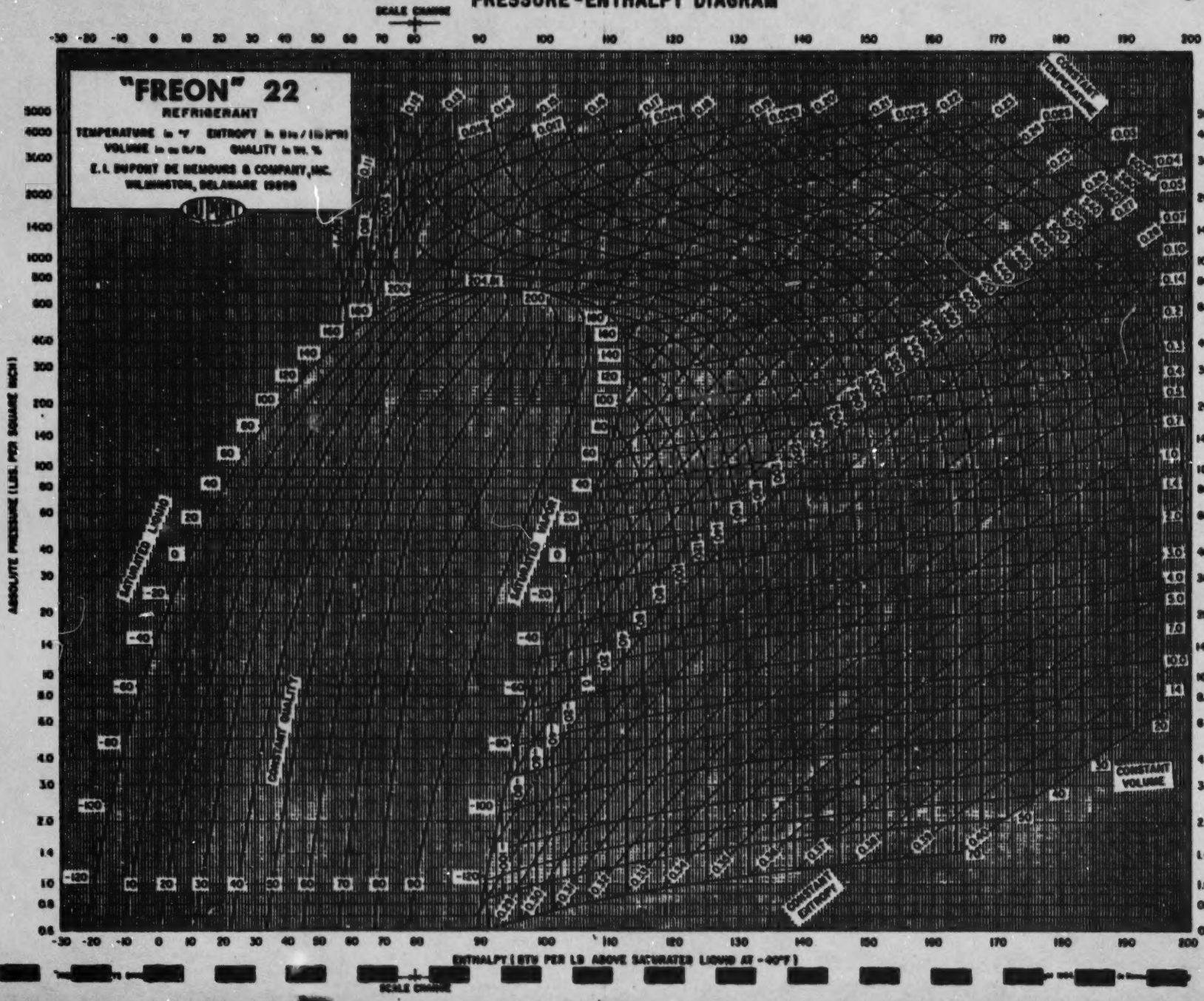
3) With an evaporating temperature of 18° and a condensing temperature of 150° and the liquid ahead of the expansion valve at 110° on a R12 system.

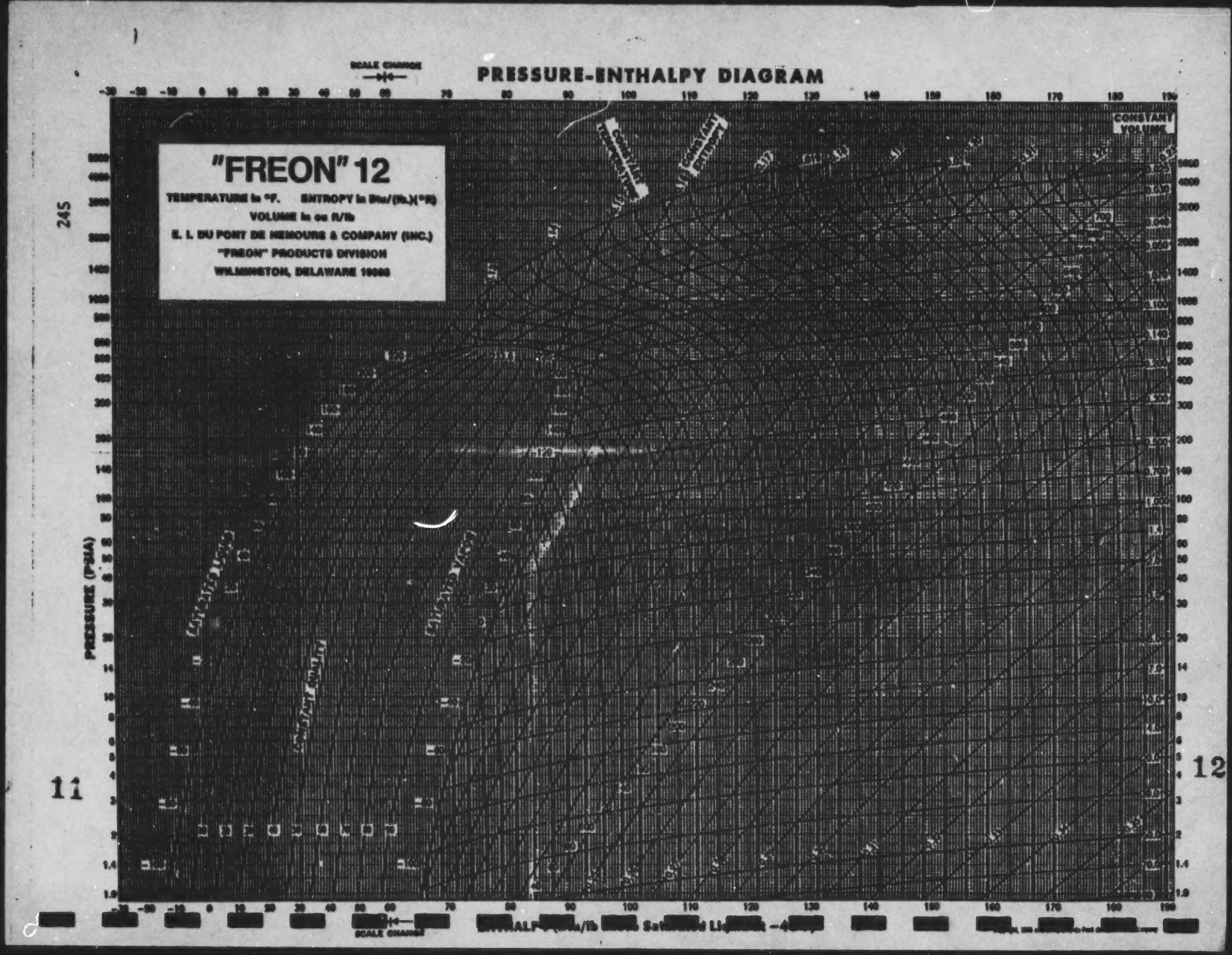
a) Find the refrigerating effect
b) the weight of refrigerant to be circulated per minute per ton
c) the piston displacement theoretically required for a 50 ton system
d) the piston displacement actually required for a 25 ton system

4) Given a system using R12 refrigerant having a condensing temperature of 119°F and an evaporation temperature of 32°F with 20° of sub cooling and 15° of superheat. Assuming all superheating is done in the evaporation coil, answer the following. After plotting on a PH chart.
(PH chart will also be graded)

a. condensor pressure
b. evaporation pressure
c. liquid ahead of expansion valve
d. temperature of hot gas leaving the compressor
e. constant quality of liquid entering the evaporation coil
f. the refrigerating effect of this unit.

PRESSURE-ENTHALPY DIAGRAM




PRESSURE-ENTHALPY DIAGRAM
"FREON" 12
TEMPERATURE in °F. ENTROPY in Btu/(lb.)(°R)
VOLUME in cu ft/lb
E. I. DU PONT DE NEMOURS & COMPANY (INC.)
"FREON" PRODUCTS DIVISION
WILMINGTON, DELAWARE 19898
CONSTANT VOLUME
CONSTANT ENTHALPY
CONSTANT TEMPERATURE
PRESSURE (PSIA)
SCALE CHANGE
245
11
12

NAME-

Unit 19 - Quiz #2

TIME-

GIVEN: $C = 0.06\ c\ VTE$ $\qquad V = \frac{28.8}{\text{TEMPERATURE RISE OF CONDENSER WATER}}$

C = ANNUAL COST OF CONDENSER WATER, DOLLARS

c = COST OF WATER, DOLLARS PER 1000 GALLONS

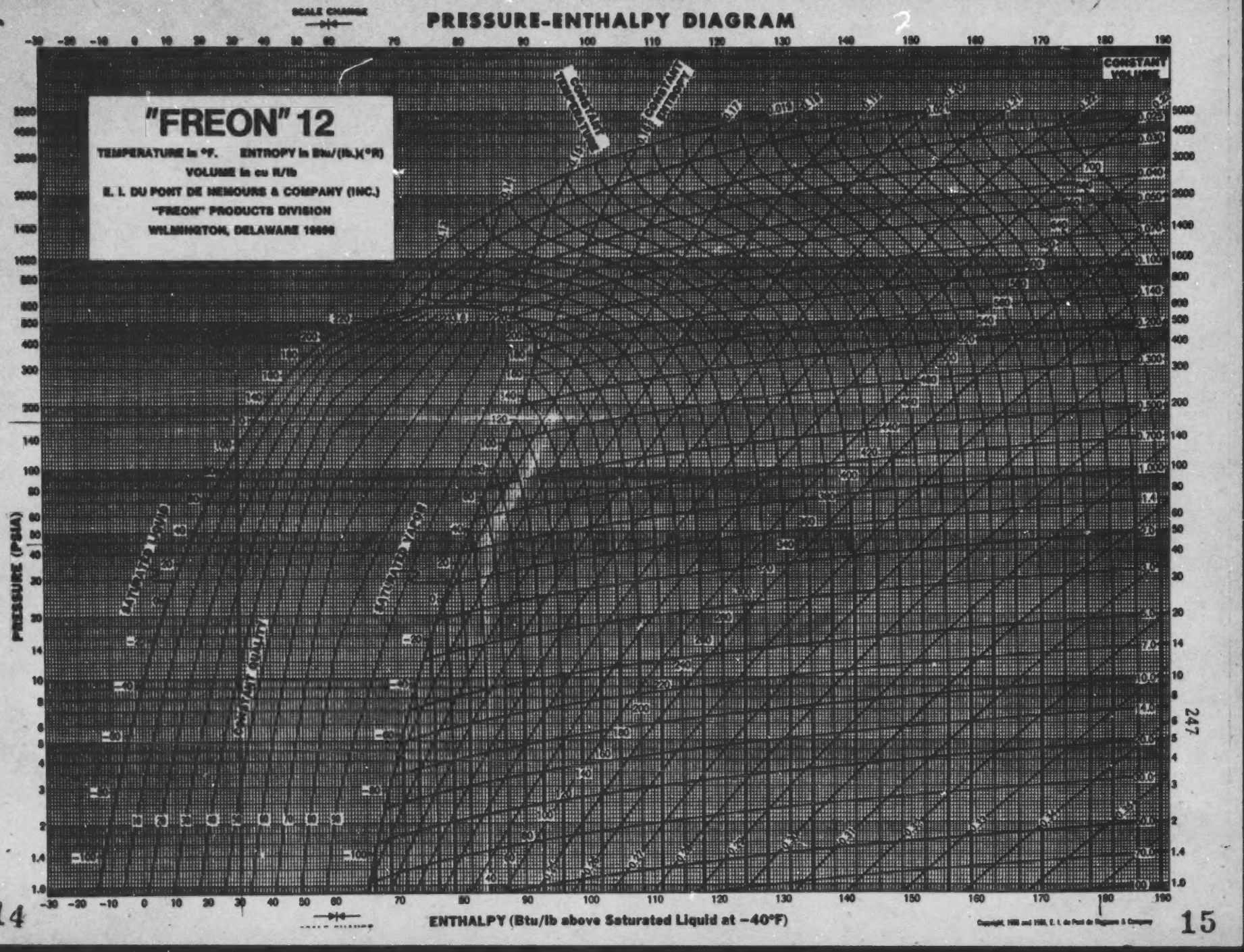
V = WATER QUANTITY, GALLONS PER MINUTE PER ONE TON

T = REFRIGERATION AT DESIGN LOAD / TONS

E = EQUIVALENT FULL LOAD OPERATING HOURS PER YEAR

A WATER-COOLED CONDENSER IS BEING CONSIDERED FOR A 15 TON PACKAGE AIR CONDITIONER SERVICING A JEWELRY STORE IN CHICAGO. THIS STORE DEMANDS 750 FULL LOAD HOURS PER YEAR. THE COST OF WATER IS $0.30 PER 1000 GALLONS. THE TEMPERATURE RISE OF THE WATER IN THE CONDENSER IS 20 F.

ESTIMATE THE ANNUAL COST OF CONDENSING WATER.



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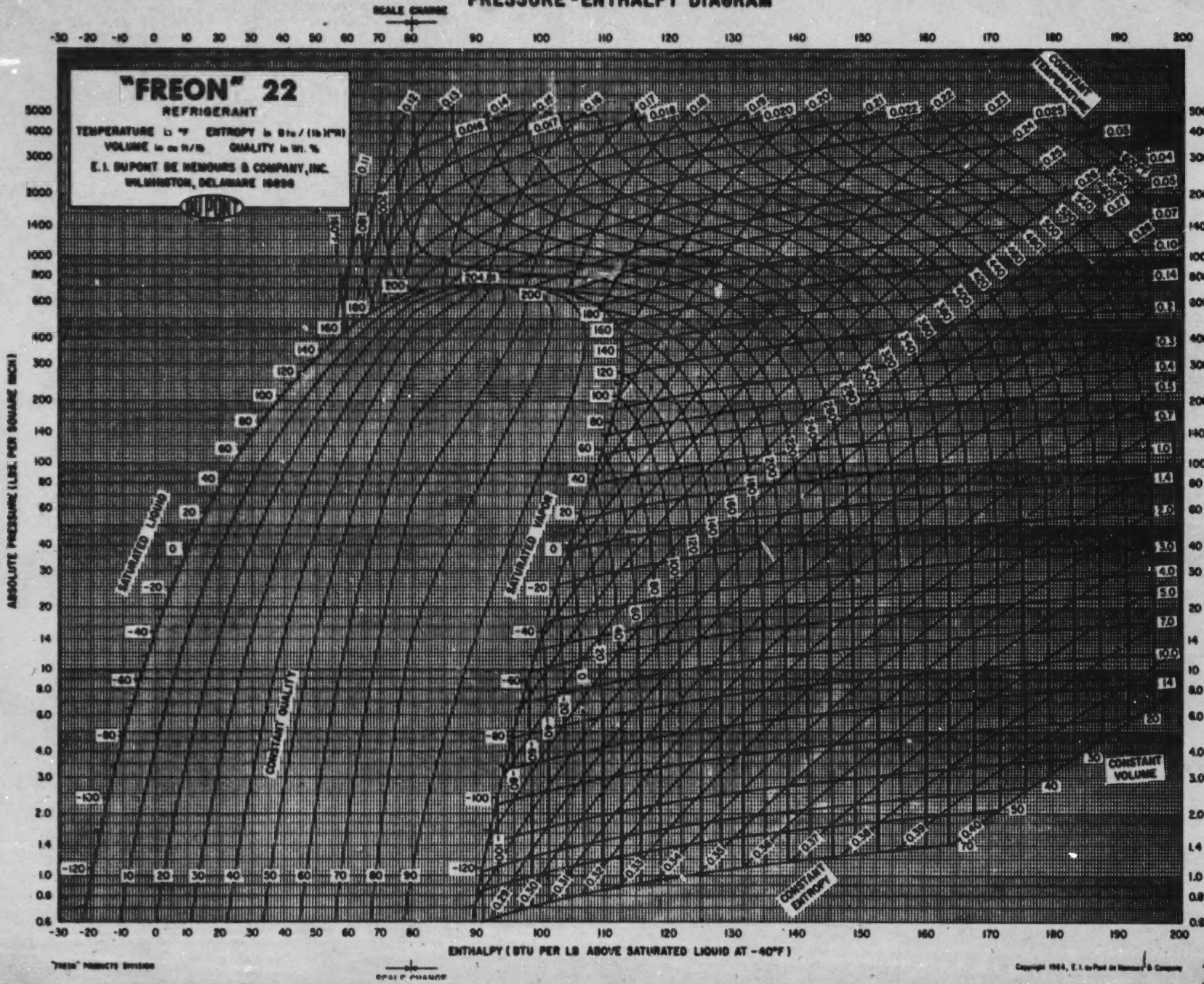
PRESSURE-ENTHALPY DIAGRAM



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AREA - REFRIGERATION THEORY

Unit 20 - Air Conditioning Systems, Advanced

I. Instructional Objectives
To acquaint student with refrigeration systems other than reciprocating type. To familiarize students with similarities and differences between systems. Teaching student fan theory and total comfort of centrifugal, absorption, heat pump, solar.

II. Reference Materials
Trane Air Conditioning Manual 7, 8, 9, 10
Basic Air Conditioning, 14, 17
Principles of Refrigeration, 18, 19
Trane Centravac Operation and Maintenance Manual
Carrier Open Drive Centrifugal Liquid Chiller Manual

III. Visual Aids
Overheads made from manufacturers installation and service manuals
On site field trips of existing equipment

IV. Method Performance Conditions
Student will be taken through step by step operation and servicing and maintenance of all systems listed above. Students will be able to name and follow use of all systems components and cycles. Student will write up findings from field trips to existing installations.

V. Outline

1. Centrifugal refrigeration system.
2. Control of centrifugal.
3. Capacity control methods.
4. Absorption system.
5. Heat pump - systems.
6. Source of heat.
7. Use of solar energy.
8. Air wash units
9. Fan theory.
10. Air pressure in ducts.
11. Fan efficiency and design.

VI. Student Evaluation Parameters

Students will determine all components and cycle of operation of all types of equipment. This evaluation will be done on paper due to the size of equipment and the complexity of having this type of large commercial equipment available in the lab. Student will give speech on one type of system before rest of class or instructor.

VII. Sequence of Instruction

1. Read all reference materials.
2. Discuss all systems in class.
3. Tour sites with different applications of systems.
4. Take unit tests.
5. Student gives speech on topic.

Unit 20 - Speech Evaluation Chart

STUDENT_____ PERIOD_____ SUBJECT_____

Double plus--Excellent
Plus --Good
Check --Fair
Minus --Weak

Subject and purpose of speech
- Appeal of subject_____
- Clearly formulated purpose (need)_____
- Adaptation of subject to audience_____

Organization and development of material
- Introduction_____
- Body_____
  - Clarity of main points_____
  - Use of supporting details_____
  - Use of transitional words_____
- Conclusion_____

DELIVERY
- Self-confidence_____
- Desire to communicate_____
- Contact with audience_____

PHYSICAL BEHAVIOR
- Posture_____
- Poise_____
- Movement and gestures_____
- Facial expression_____

VOCAL EFFECTIVENESS
- Volume_____ Rate_____ Pitch_____ Force and emphasis_____
- Distinctness (Enunciation)_____

COMMAND OF ENGLISH
- Grammar_____
- Sentences_____
- Pronunciation_____
- Fluency_____
- Excessive use of 'ands & uhs'_____

COMMENTS:

GRADE_____

20

Unit 20 - Quiz #1

Name_____

T or F 1. A centrifugal compressor is a positive displacement machine.

T or F 2. Refrigerant 113 is used for small capacity centrigugals.

T or F 3. Refrigerant 12 gives the highest CFM per ton flow rate of all refrigerants.

T or F 4. There are two classes of Centrifugal Compressors, open and hermetic.

T or F 5. Centrifugal Compressors are lubricated by a very complicated grease pump.

6. Oil temperature in a Centrifugal is very important. Its control devices utilize (circle three that apply)
   a. two stage thermostat
   b. oil cooling coil
   c. anti-foam screen
   d. thermal ice sensor
   e. solenoid valve

T or F 7. An electric heating element keeps the compressor warm even in off-cycle.

T or F 8. The surge point of a centrifugal is an operating characteristic.

T or F 9. A shell-and-tube heat exchanger is another name used for a condenser.

T or F 10. In a centrifugal system, noncondensible gases and water vapor are collected and removed through a manual skimming.

11. The evaporation for a centrifugal is of the (choose one)
   a. flooded type
   b. direct expansion type
   c. capillary reaction type
   d. float valve type
   e. semiflooded type

12. A_____plate is used in both the condenser and evaporation section of a centrifugal system to distribute refrigerant uniformally.
   a. restrictor
   b. baffle
   c. metal
   d. flexible
   e. discharge

13. Capacity Control of centrifugals can be accomplished in many ways (choose 3 that pertain).
    a. off-on control
    b. unloaders
    c. hot gas by-pass
    d. condenser water regulator
    e. butterfly dampers

T or F 14. Variable inlet guide vanes when closed cause a pressure drop which in turn decreases the specific volume of gas entering the impeller.

T or F 15. The use of variable inlet guide vanes is the most economical means of capacity control.

T or F 16. The centrifugal compressor can not start until certain safety controls allow it to do so.

17. A centrifugal system may be defined as a large capacity unit that handles large volumes of refrigerated
    a. liquid
    b. water
    c. air
    d. gas

18. The velocity energy in an impeller of a centrifugal system is converted to
    a. gas
    b. heat
    c. pressure
    d. low temperature

19. The load ranges of a centrifugal machine are
    a. 3 to 5000 tons
    b. 3 to 4000 tons
    c. 5 to 4500 tons
    d. 50 to 4500 tons

T or F 20. The efficiency loss for small impellers is about the same as for larger impellers

T or F 21. Variable inlet guide vanes prevent air and water from entering a centrifugal unit.

22. The most common refrigerants used in centrifugal systems are
    a. R11 & R12
    b. R11 & R114
    c. R12 & R113
    d. R11 & R113

The following questions apply to capacity control methods. Match the answers below to the following questions.

a. On & Off control
b. Hot gas by-pass control
c. Condenser water regulation
d. Butterfly dampers
e. Speed control
ab. Variable inlet guide vanes.

23. A thermostatic control is used to sense the chilled water temp. leaving the evaporator. This decrease indicates a drop in load.

24. This control is usually located in suction line and is used to lower the surge point.

25. This control is uneconomical as there is a reduction in power input to the compressor once the control starts to open.

26. This control gives us a higher first cost because of a larger compressor and drive and a higher operating cost because of lower efficiency.

27. If this control were used six to eight times a hour it would be prohibitive for satisfactory motor life.

28. This control device is operated by pneumatic linkages.

29. Spins the gas flowing into the impeller in the direction of the impeller rotation.

30. Experience has shown that the best control and economy is obtained by providing both stages of a two-stage machine with this control.

The following questions apply to Absorption Systems-Lithium Bromide & Water-Type.

T or F 31. Some manufacturers use fixed and floating supports to control tube expansion in the concentrator.

T or F 32. Copper tubes are the most suitable material for the absorber.

33. At the present time, the unit sizes of absorption refrigeration equipment covers a capacity range of
    a. 10 to 1000 tons
    b. 3 to 1600 tons
    c. 5 to 1200 tons
    d. 50 to 1500 tons

    The following questions apply to terms used when discussing the absorption refrigeration system

    a. Absorbent
    b. Absorber
    C. Concentrator
    d. Concentrated Solution
    e. Dilute Solution
    ab. Condenser
    ac. Evaporator
    ad. Heat Exchanger
    ae. Heat of Condensation
    bc. Heat of Dilution
    bd. Sensible Heat

34. A device used to transfer heat between two physically separate fluids.

35. An absorbent solution diluted by a large amount of dissolved refrigerant.

36. Used to raise or lower the temperature of a substance.

37. A vessel in which vaporized refrigerant is liquefied by removal of heat.

38. Heat released when two liquids are mixed.

39. A vessel in which refrigerant is vaporized to produce a refrigerating effect.

40. The heat released when a vapor condenses to a liquid.

41. A vessel containing a solution of absorbent and refrigerant to which heat is supplied for the purpose of boiling away some of the refrigerant.

42. A substance capable of taking in and retaining moisture from the atmosphere.

43. A vessel for containing liquid for absorbing refrigerant vapor.

44. A solution with a large concentration of absorbent and only a small amount of sissolved refrigerant.

The following questions apply to an amonia and water absorption system.

T or F 45. There are two types of absorption refrigerators One uses a solid absorbing material; the other uses a liquid absorbent.

T or F 46. Absorption systems are futher classified as intermediate systems and continuous systems.

47. Check any that apply to evaporator section of absorber.
   a. Refrigerant at low pressure
   b. Pressure of refrigerant rises
   c. Portion of refrigerant flashes
   d. Spray trees and pump used
   e. Heat for vaporization comes from electric heater

48. Check any that apply to absorber section.
   a. Reclaims refrigerant
   b. Pressure lowest in system
   c. Same accomplishments as a compressor
   d. Pressure highest in system
   e. Refrigerant absorbed by concentrated salt solution

49. Check any that apply to concentrator section.
   a. Cold applied to salt solution
   b. Refrigerant boils off
   c. Vapor at high pressure
   d. Diluted salt solution present
   e. Temperatures and pressures lowest in system

50. Check any that apply to condenser section.
   a. High pressure refrigerant vapor present
   b. Liquid refrigerant at bottom
   c. Hot water vaporizes refrigerant
   d. Tubing bundle present
   e. Gravity flow

51. Briefly describe the cycle of a centrifugal refrigeration system. Include the names of parts or controls.

52. Briefly describe the cycle of a Absorption System (Lethium Bromide & Water).

Unit 20 - Quiz #2

Name_____

THESE QUESTIONS ARE ON THE TRANE ABSORPTION UNIT WE SAW ON OUR FIELD TRIP.

1. Looking at the front of the unit we saw the: (check any that apply)
   a. condenser header
   b. evaporation header
   c. concentrator header
   d. absorber header
   e. purge pump

F 2. The solution pump was located underneath the unit.

T,F 3. The entire unit was controlled by pneumatic controls.

F 4. Purging of the unit had to be done once a week.

T,F 5. The heat exchanges was supplied with heat by a gas flame.

F 6. The secondary tower water needed no treatment at all.

F 7. The tower was located on the roof which is the best place for a tower.

T,F 8. The stationary engineer that showed us his equipment was very happy with its operation.

F 9. The tubes in the absorber have to be replaced once a season.

T,F 10. The air handlers were located in the penthouse and had roller type filter mechanisms.

THE FOLLOWING QUESTIONS ARE ON THE LAST 4 WEEKS OF TALKS.

T,F 11. Volumetric efficiency is the ratio of the actual volume of refrigerant gas pumped, DIVIDED By THE THEORETICAL VOLUME OF THE COMPRESSOR

F 12. An evaporation cooler uses R22 refrigerant as its principal heat conducting agent.

F 13. Air filteration can be divided into three classifications, viscous impingement, dry type, and electronic.

14. Water comes from three major sources for use in Air Conditioning. List three.
   a. municipal systems
   b. surface water
   c. cactus water
   d. coconut water
   e. well water

T,F 15. Heat transfer levels in a home can be measured, according to Construction Materials.

F 16. Evaporators are any devise in which a refrigerant is evaporated for the purpose of extracting heat from the surrounding medium.

F 17. During compression stroke in a reciprocating compressor the temperature of the gaseous refrigerant is dropped to a level were it helps to cool the compressor.

F 18. Solar energy being used by humans dates back as far as 215BC where it was used to set fire to ships.

T,F 19. The primary purpose of a condenser is to liquify the refrigerant vapor.

T,F 20. Ventilation can be done either naturally or through mechnical means.

T,F 21. Thermodynamically the centrifugal refrigeration cycle is identical to the vapor compressor cycle of the reciprocating compressor.

T,F 22. Comfort level is the amount a human body is able to accustom itself to a certain amount of change in a given time.

T,F 23. The expansion valve is used at the leaving side of an evaporation coil to regulate flow of refrigerant.

24. An ideal piping system should give: (Pick any that apply)
   a. proper oil return
   b. maximum capacity
   c. minimum power consumption
   d. minimum refrigerant charge
   e. low noise level

T,F 25. Air washers are assembled to bring air and water together in a spray chamber.

T,F 26. Relative humidity is the ratio of the water vapor present in the air to the maximum amount possible at that temperature.

T,F 27. Ice could be considered as one of our first refrigerants.

T,F 28. Dew point is the humidity level at which moisture will start to condense from the air.

T,F 29. Absorption units were popular the late 1800's and early 1900's.

T,F 30. Conservation of Energy can be obtained by building your house deep into the ground.

31. PH Charts show five basic parts of a refrigeration system. (circle any that apply)
   a. condenser
   b. throttling device
   c. evaporator
   d. suction line
   e. compressor

T,F 32. Heat pumps can get their source of heat from air, water or the earth.

T,F 33. We measure pressures(atmospheric) in inches of mercury using a tube approximately 36" long.

T,F 34. The psychrometric chart can show use the relative humidity of air.

T,F 35. The steam system for cooling is based on reducing pressure enough for water to boil.

T,F 36. Ice can be used for cooling in what is called a bunker melting system.

Unit 20 - Quiz #3

Psychrometric Test

Instructions: The questions used on this quiz are to test your knowledge on basic facts pertaining to the Psychrometric Chart. There is only one correct answer for each question.

T or F 1. A psychrometer is used to measure both wet bulb and dry bulb temperatures.

T or F 2. The hotter the air becomes, the less moisture it will hold.

T or F 3. Using the Psychrometric chart as a tool, you can solve problems in an air cooled condensor.

T or F 4. A pound of water contains approximately 7,000 grains.

T or F 5. As the dry bulb temperature of air decreases, the volume will decrease.

T or F 6. One cubic foot of air has a weight of one pound.

T or F 7. Dry air is composed mainly of nitrogen and oxygen.

T or F 8. Relative humidity has very little effect on human comfort.

T or F 9. Relative humidity and percentage of humidity are the same.

T or F 10. The wet bulb temperature and the dry bulb temperature are read on the same line on the psychrometric chart.

T or F 11. A sling psychrometer will give dewpoint temperatures.

T or F 12. Most homes are designed to hold a relative humidity of 35% at 20 outdoor temperature.

T or F 13. Relative humidity is the weight of water in the air.

T or F 14. It requires approximately 1000 BTU's of heat to evaporate one pound of water into the air.

T or F 15. Grains of moisture and specific humidity are the same.

Multiple Choice: Select the correct answer.

16. A vertical move on the psychrometric chart will show a change in:
    A. Latent heat
    B. Sensible heat
    C. Dry bulb temperature

MULTIPLE CHOICE: (CONT.)

17. IN A HORIZONTAL MOVE ON THE PSYCHROMETRIC CHART, WHAT WILL REMAIN THE SAME?
    A. WET BULB
    B. DRY BULB
    C. RELATIVE HUMIDITY
    D. SPECIFIC HUMIDITY

18. AS THE OUTDOOR TEMPERATURE INCREASES ON A SUMMER DAY, AND NO RAIN TAKES PLACE, THE HUMIDITY WILL:
    A. INCREASE
    B. DECREASE
    C. REMAIN THE SAME

19. AS AIR IS SENSIBLY HEATED THE VOLUME WILL:
    A. INCREASE
    B. DECREASE
    C. REMAIN THE SAME

20. AIR HAVING A DRY BULB TEMPERATURE OF 60° AND AND WET BULB TEMPERATURE OF 60° WILL HAVE A RELATIVE HUMIDITY OF:
    A. 25%
    B. 50%
    C. 75%
    D. 100%

AIR ENTERS A SATURATOR WHICH IS 100% EFFICIENT. THE CHARACTERISTIC OF THE AIR COMING OUT WILL CHANGE. USING THE TERMS:

A. INCREASE
B. DECREASE
C. REMAIN THE SAME

ANSWER THE FOLLOWING QUESTIONS. (21-27)

21. THE DRY BULB TEMPERATURE WILL:

22. THE WET BULB TEMPERATURE WILL:

23. THE RELATIVE HUMIDITY WILL:

24. THE SPECIFIC HUMIDITY WILL:

25. THE VOLUME WILL:

26. THE ENTHALPY WILL:

27. THE DEW POINT TEMPERATURE WILL:

AIR ENTERS AN AIR CONDITIONG EVAPORATOR. THE SYSTEM IS OPERATING PERFECTLY. THE PROPER VOLUME OF AIR IS BEING DELIVERED BY THE FAN. (400 CFM/TON). USING THE TERMS:

A. INCREASE
B. DECREASE
C. REMAIN THE SAME

ANSWER THE FOLLOWING QUESTIONS. (28-34)

CONDITIONS OF LEAVING AIR.

28. THE DRY BULB TEMPERATURE WILL:

29. THE WET BULB TEMPERATURE WILL:

30. THE RELATIVE HUMIDITY WILL:

31. THE SPECIFIC HUMIDITY WILL:

32. THE VOLUME WILL:

33. THE ENTHALPY WILL:

34. THE DEW POINT TEMPERATURE WILL:

THE FOLLOWING QUESTIONS DEAL WITH AN INCREASE OF AIR VELOCITY OVER AN EVAPORATOR COIL. THE SYSTEM IS DESIGNED FOR 1200 CFM (3 TON). YOU WOULD EXPECT TO FIND WHAT CONDITIONS OF THE AIR BY PLOTTING ON THE CHART. (QUESTIONS 35-40)

35. DRY BULB TEMPERATURE OF AIR LEAVING COIL:
A. HIGHER
B. LOWER
C. SAME

36. DEW POINT TEMPERATURE OF AIR LEAVING COIL:
A. HIGHER
B. LOWER
C. SAME

37. WET BULB TEMPERATURE OF AIR LEAVING COIL:
A. HIGHER
B. LOWER
C. SAME

38. PELATIVE HUMIDITY OF AIR LEAVING COIL:
A. HIGHER
B. LOWER
C. SAME

39. SPECIFIC HUMIDITY OF AIR LEAVING COIL:
A. HIGHER
B. LOWER
C. SAME

40. TOTAL ENTHALPY OF AIR LEAVING COIL:
    A. HIGHER
    B. LOWER
    C. SAME

THE FOLLOWING QUESTIONS DEAL WITH A DECREASE OF AIR VELOCITY OVER AN EVAPORATOR COIL. SYSTEM IS DESIGNED FOR 1200 CFM (3 TON) BUT THE FAN IS DELIVERING ONLY 1000 CFM (3 TON). YOU WOULD EXPECT TO FIND WHAT CONDITIONS OF THE AIR BY PLOTTING ON THE CHART. (QUESTIONS 41-45)

41. DRY BULB TEMPERATURE OF AIR LEAVING COIL:
    A. HIGHER
    B. LOWER
    C. SAME

42. WET BULB TEMPERATURE OF AIR LEAVING COIL:
    A. HIGHER
    B. LOWER
    C. SAME

43. SPECIFIC HUMIDITY OF AIR LEAVING COIL:
    A. HIGHER
    B. LOWER
    C. SAME

44. DEW POINT TEMPERATURE OF COIL:
    A. HIGHER
    B. LOWER
    C. SAME

45. TOTAL ENTHALPY OF AIR LEAVING COIL:
    A. HIGHER
    B. LOWER
    C. SAME

Unit 20 - Quiz # 4

Name _____

Section _____

Psychrometric Test

INSTRUCTIONS: The questions used on this quiz are to test your knowledge on basic facts pertaining to the Psychrometric Chart. There is only one correct answer for each question. The test is worth a total of 75 points. The time allowed will be 45 minutes. Place all answers in the column to the left.

1. _____ 1. A psychrometer is used to measure both wet bulb and dry bulb temperatures.
   a. true
   b. false

2. _____ 2. The hotter the air becomes, the less moisture it will hold.
   a. true
   b. false

3. _____ 3. Using the Psychrometric Chart as a tool, you can solve problems in an air cooled condensor.
   a. true
   b. false

4. _____ 4. A pound of water contains approximately 7,000 grains.
   a. true
   b. false

5. _____ 5. As the dry bulb temperature of air decreases, the volume will decrease.
   a. true
   b. false

6. _____ 6. One cubic foot of air has a weight of one pound.
   a. true
   b. false

7. _____ 7. Dry air is composed mainly of nitrogen and oxygen.
   a. true
   b. false

8. _____ 8. Relative humidity has very little effect on human comfort.
   a. true
   b. false

9. _____ 9. Relative humidity and percentage of humidity are the same.
   a. true
   b. false

10. _____ 10. The wet bulb temperature and the dry bulb temperature are read on the same line on the psychrometric chart.
   a. true
   b. false

23. _____ 23. As the outdoor temperature increases on a summer day, and no rain takes place, the humidity will:
a. increase
b. decrease
c. remain the same

24. _____ 24. As air is sensibly heated the volume will:
a. increase
b. decrease
c. remain the same

25. _____ 25. Air having a dry bulb temperature of 60° and a wet bulb temperature of 60° will have a relative humidity of:
a. 25%
b. 50%
c. 75%
d. 100%

Air enters a saturator which is 100% efficient. The characteristic of the air coming out will change. Using the terms:
a. increase
b. decrease
c. remain the same
answer the following questions (questions 26-32).

Condition of leaving air.

26. _____ 26. The dry bulb temperature will:

27. _____ 27. The wet bulb temperature will:

28. _____ 28. The relative humidity will:

29. _____ 29. The specific humidity will:

30. _____ 30. The volume will:

31. _____ 31. The enthalpy will:

32. _____ 32. The dew point temperature will:

Air enters an air conditioning evaporator. The system is operating perfectly. The proper volume of air is being delivered by the fan (400 CFM/Ton). Using the same method of answering used in the previous seven questions (A, B, or C), answer the following:

Conditions of leaving air.

33. _____ 33. The dry bulb temperature will:

34. _____ 34. The wet bulb temperature will:

35. _____ 35. The relative humidity will:

36. _____ 36. The specific humidity will:

37. _____ 37. The volume will:

38. _____ 38. The enthalpy will:

39. _____ 39. The dew point temperature will:

The following questions deal with an increase of air velocity over an evaporator coil. The system is designed for 1200 CFM (3 Ton). You would expect to find what conditions of the air by plotting on the chart (questions 40-45).

40. _____ 40. Dry bulb temperature of air leaving coil:
a. higher
b. lower
c. same

41. _____ 41. Dew point temperature of air leaving coil:
a. higher
b. lower
c. same

42. _____ 42. Wet bulb temperature of air leaving coil:
a. higher
b. lower
c. same

43. _____ 43. Relative humidity of air leaving coil:
a. higher
b. lower
c. same

44. _____ 44. Specific humidity of air leaving coil:
a. higher
b. lower
c. same

45. _____ 45. Total enthalpy of air leaving coil:
a. higher
b. lower
c. same

The following questions deal with a decrease of air velocity over an evaporator coil. System is designed for 1200 CFM (3 Ton) but the fan is delivering only 1000 CFM (3 Ton). You would expect to find what conditions of the air by plotting on the chart (questions 46-50).

46. _____ 46. Dry bulb temperature of air leaving coil:
a. higher
b. lower
c. same

47. _____ 47. Wet bulb temperature of air leaving coil:
a. higher
b. lower
c. same

48. _____ 48. Specific humidity of air leaving coil:
a. higher
b. lower
c. same

49. _____ 49. Dew point temperature of coil:
a. higher
b. lower
c. same

50. _____ 50. Total enthalpy of air leaving coil:
a. higher
b. lower
c. same

The following questions deal with the skeleton graph of the psychrometric chart. Using the chart, place the correct answers in the column to the left.

Example: Given point X on graph, in which square would you find the values for the following:

J 10 a. Wet bulb
N 12 b. Relative humidity

From point A on graph, in which square would you find the values for the following:

51. _____ 51. Dry bulb temperature

52. _____ 52. Wet bulb temperature

53. _____ 53. Dew point temperature

54. _____ 54. Specific humidity

55. _____ 55. Volume

56. _____ 56. Enthalpy

From point B on graph, in which square would you find the values for the following:

57. _____ 57. Grains of moisture

58. _____ 58. Relative humidity

59. _____ 59. Dew point temperature

60. _____ 60. Specific humidity

61. _____ 61. Wet bulb temperature

62. _____ 62. Dry bulb temperature

63. _____ 63. Volume

64. _____ 64. Enthalpy

From point C on graph, in which square would you find the values for the following:

65. _____ 65. Wet bulb temperature

66. _____ 66. Grains of moisture

67. _____ 67. Enthalpy

68. _____ 68. Volume

69. _____ 69. Relative humidity

70. _____ 70. Dry bulb temperature

From point D on graph, in which square would you find the values for the following:

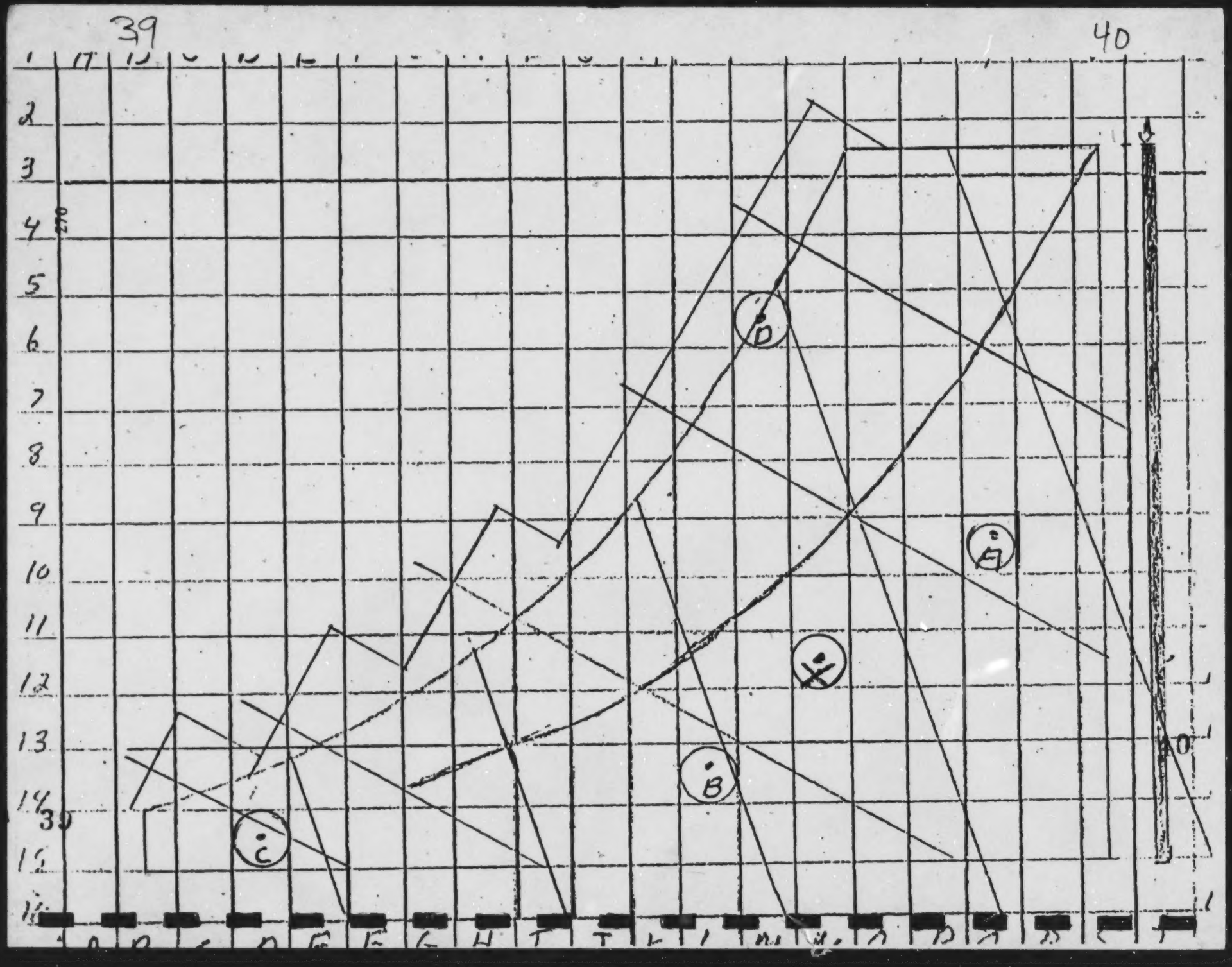
71. _____ 71. Specific humidity

72. _____ 72. Dew point temperature

73. _____ 73. Volume

74. _____ 74. Relative humidity

75. _____ 75. Wet bulb


39
40
D
E
B
C

AREA - REFRIGERATION SERVICE PROCEDURES

Unit 21 - Beginning Service Procedures, Instruments

I. Instructional Objectives

Student will be acquainted with tools necessary to work with refrigerant tubings. Soldering tools. Student will develop and understand pressures with which refrigeration personnel must be concerned. Students will develop techniques used and proper care of gauges involved in reading pressures. Development of proper use and care of electrical meters and attitudes in safe usage of tools will be stressed. All hand tools used in the HVACS trades will be explained and most will be used by students.

II. Reference Materials

Refrigerant Manual by DuPont, all
Refrigeration and Air Conditioning, ARI, 1, 3, 4, 5
Copper Tube-Copper Development Assist., all
Carrier GTR Series, 11, 12, 13

III. Visual Aids

Carrier slides, GTR Series, 11, 12, 13
Overheads, Burnout Procedures and PT charts

IV. Method Performance Conditions

Given copper, steel, aluminum, plastic tubing and solders or epoxies, oxyecetelene torches, propane and acetelene, high air volumn torches, electrical test meters such as amprobe, Simpson 260, Annie, etc. Gauge manifolds 3 and 4 hose, vacuum pump, high and low velocity. Leak testers, Hailigte, Halogen, electronic refrigerants R22 and 12, test units, charging equipment.

V. Outline

1. Hand tools, refrigeration tools and materials.

   A. Safety

   B. Methods of use

   C. Fittings

   D. Information
      a. Ch. 2 of Modern Refrigeration & Air Conditioning
      b. handouts
      c. cassette/slide presentation

2. Swedging

   A. Class demonstration

B. Lecture

C. Lab - student completes good swedges of all sizes of copper, ¼, 3/8, ½ and 5/8"

3. Flaring

A. Single flare

B. Double flare

C. Information
   a. handouts
   b. demonstration and lecture
   c. lab - student completes good single flares using flaring block for ¼, ½, 3/8, 5/8, and 3/4" by using ball peen

4. Soft soldering 95/5

A. Cleaning methods

B. Fluxing methods

C. Safe use of Acetylene and Propane torches

D. Soldering methods

E. Information
   a. handouts
   b. demonstration and lecture
   c. Lab - students complete good "sweat joints" of all sizes of copper. Swedges copper first. Have students cut and "peel" open each joint for instructor's inspection

5. SIL-FLOS

A. Safe use of Turbotorch and Oxy-acet. torch

B. Methods of Sil-flosing using Turbotorch and Oxy-acet.

C. Information
   a. handout
   b. demonstration and lecture
   c. Lab - students complete swedged Sil-flos joints using both Turbotorch and Oxy-acet. torch. Cut joint apart at 45° to check for penetration.

6. Silver brazing

A. Brazing methods using both torches.

B. Demonstration and lecture only - no lab

7. Alumn-Weld

A. Method of Alumn-welding using kit

B. Demonstrate and lecture

C. Lab - let students try using alumaweld kit.

8. Gauge manifolds

A. Different between absolute and gauge pressure

B. How to read pressure, vacuum and temp. from gauges

C. Types of manifolds
   a. 3-hose
   b. 4-hose
   c. hi-vacuum

D. Use of each type of manifold

9. Service valves

A. In-line service

B. Pad

C. Schrader valve

D. Harding valve

E. Add-on type

10. Refrigerants

A. Types

B. Characteristics

C. Safety

D. Cylinder types

E. Information
   a. handouts
   b. lecture
   c. Ch. 9 Modern Refrigeration and Air Conditioning

11. Leak testing

A. Haliae Torch

B. Soap bubbles

C. Electronic

D. Sonic

E. Information

a. handouts
b. demonstration and lecture
c. lab - students practice first three types of leak detection
d. use Chapter 11, Modern Refrigeration & Air Conditioning for rest of course and handouts

12. Evacuation

A. Pumps
a. single and double stage piston
b. single and double stage rotary vane

B. Methods of evacuation
a. triple evacuation
b. deep vac. using Thermistor Vacuum Gauge
c. explain use and purpose of Thermister Vac. Gauge

C. Information
a. demonstrate - boil water in bell jar using deep vac.
b. lab - evacuate units that have been leak tested

13. Charging methods

A. Pressure chart method

B. Sight Glass Method - expansion valve only

C. Super heat method - expansion valve only

D. Frost line method

E. Head pressure method

F. Dial-a-charge weigh in method

G. demonstrate and lecture all above

H. Lab - let students attempt as many methods of charging as time allows.

14. Continue charging methods

VI. Student Evaluation Parameters

Student will be capable of using all types of soldering equipment and will perform connections of all types and on all types of tubing used in refrigeration. Student will attach charging manifolds to equipment, leak testing, evacuating and charging all types of equipment.

VII. Sequence of Instruction

1. Read all reference materials.
2. View all visual aids.
3. Discuss proper procedure for doing all required projects.
4. Do lab project.
5. Take unit tests.

Unit 21 - Sample Lab Project

OBJECT -

To become familiar with cuttings and flaring tools and develop the skills necessary to make good mechanical and leak-proof flare connections.

Material Needed -

Flaring tool

Cutting tools - Lack saw and tubing cutter

6" pieces of 1/4" O D Copper tubing

3/8" O D Copper tubing

1/2" O D Copper tubing

5/8" O D Copper tubing

3/4" O D Copper tubing

Procedure -

Cut 6" pieces of each size of copper listed. Make flares on each end after preparing ends properly. Make a double flare on the 3/8" copper using double flare kit. Make a flare on one end of the 3/4" using only a ball pen hammer. Cut tubing in half and have it checked by instructor. Repeat process until several good sucessive flares are made.

Name 276

Unit 21 - Sample Lab Project

Flaring Equipment

Take tubing cutter and cut one six inch long piece of each size of copper.

1/4"

3/8"

1/2"

5/8"

3/4"

Make a flare at each end of the tubing using flaring block and yoke. Cut tubing in half after flaring. Make these good, as they will be graded. Put all flares together with masking tape and write name on tape. Hand in project to lab instructor.

Unit 21 - Sample Lab Project

FLARING COPPER TUBING

OBJECTIVE:

To become familiar with cutting and flaring tools and to develop the skills necessary to make good mechanical and leak-proof flare connections.

DISCUSSION:

A tubing cutter or hack saw may be used to cut copper tubing to the correct length or to prepare the tubing end of a crimped (sealed) roll of tubing for flaring. Usually a cutter is used on soft tubing and the inside burr reamed to conform with the tubing inside diameter. The tubing end should be square; file if necessary, but make sure chips from reaming or filing do not fall into or remain in the tubing. Foreign material must not be present within the system. Flare nuts must be positioned on the tubing prior to clamping in the flare block when actual connections are to be made; however, we will not use flare nuts in this operation because we only intend to develop actual flaring skills and are not connecting into a system.

MATERIAL:

~~Tool kit~~
1/4" O.D. tubing
3/8" O.D. tubing
1/2" O.D. "
5/8" O.D. "

PROCEDURE:

1. Prepare the end of the ~~1/4"~~ tubing for flaring. Hold the tube upside down when reaming so chips will fall out.

2. Clamp the tubing in the proper flare block opening with the end of the tube projecting (see Figure 1) slightly above the flare block on the chambered side. Install the spinner yoke.

3. Put a little refrigerant oil on the spinner and tighten it, using an oscillating motion as directed by the instructor. Do not exert extreme pressure on the flare as this could thin the flare and result in a weak or leaky connection.

4. Repeat the above operation ~~a few times~~ ~~Minimum of~~ as directed by the instructor. Several good successive flares, approved by the instructor, should be made.

5. Repeat the above steps using the other ~~5/16"~~ tubing.

When your project is finished and approved (graded) by the instructor, please clean up your work area.

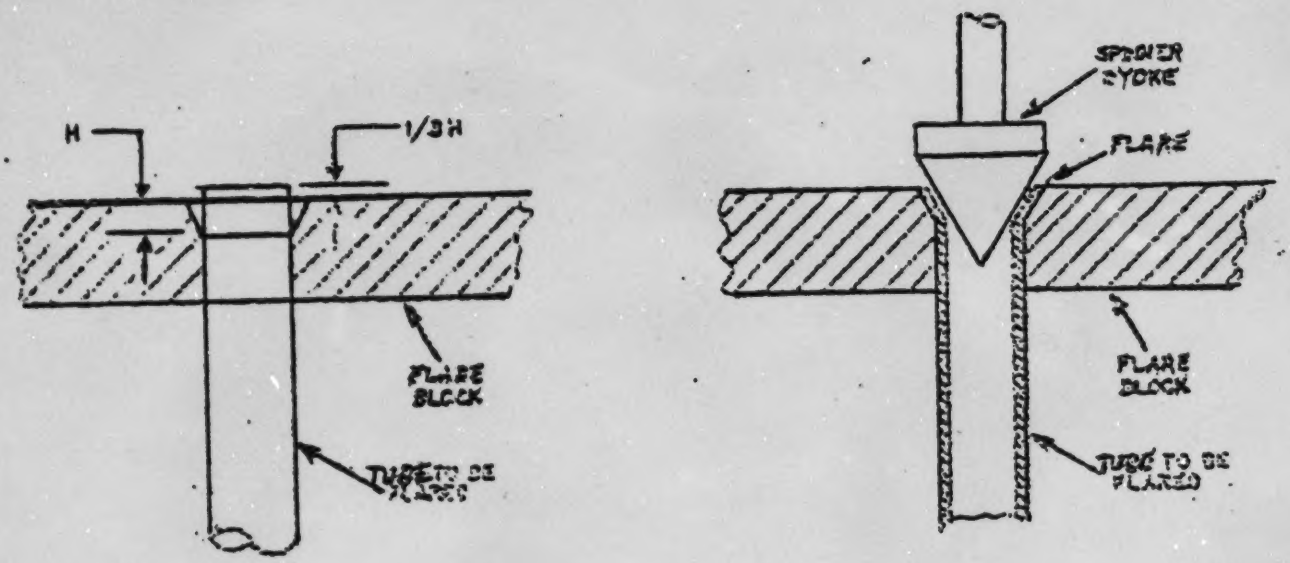


Figure 1.

Unit 21 - Sample Lab Project

Swedging

Tools needed: Hand swedges of each size: 1/4", 3/8", 1/2", 5/8".

Copper tubing 6" pieces of each size.

Block to hold copper.

Hammer to hit swedge with.

Ream and tubing cutter.

Procedure:

Cut tubing to 6" length. Ream tubing. Place tubing in block at proper height. Place swedge into copper, round on swedge with hammer with short sharp blows. Hold block in your hand. Don't lay it down on anything solid while pounding swedge. After finishing swedge, cut copper in half and see if piece cut off will fit snugly into swedge.

Ask paraprofessional for assistance. Have him check swedge for proper fit.

Unit 21 - Sample Lab Project

Use Pieces of 3/4 Copper in junk box.
Have student file weak spot in pipe and punch through, when pipe is thin enough.

Flare 1/4 Copper , form with round shaft to fit larger pipe.
Use length of pipe in coil for support. Silfloss fitting over hole in larger pipe.
Cut off 1/4 in. pipe approx. 4in. long for process stub.

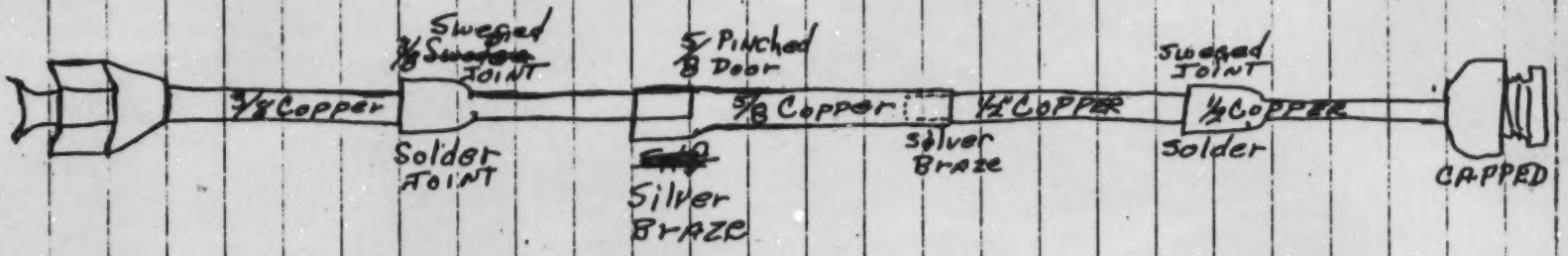
Materials Needed

1. Torch and striker.
2. 6 in. piece 3/4 in. pipe
3. 1/4 in pipe approx 3feet long.
4. File
5. Flare block and yoke.
6. Round shaft (screwdriver) or (wrench handle).
7. Punch.
8. Silfoss - 1 Piece.
9. Hammer.

Make 3- Have best one Checked.
Cut open check for good seal without drawing .
Floss over hole in large pipe.

Lab Mid Term

6 in. long Copper Sections



Pressure Checked – With Soap.

Than Split & Checked For

Penetration (Swaged Joints)

281

51

52

Unit 21 - Sample Lab Project

Soldering and Brazing A Swage Joint

Objective: to become familiar with soft soldering and brazing a swage joint.

Discussion: the first procedure in this project will be to become proficient in the use of soft solder to complete a swage joint. We will then in another shop period do a swage joint using a silver-brazing process. Mastering these skills will be equally advantageous on streamlined fittings and others found in air-conditioning and refrigeration work.

Material: tool kit
mill file
hacksaw
torch
sandpaper
soft solder (1st run of project)
silver brazing alloy (2nd run of project)
flux and 3/8" O.D. tubing

Procedure:

1. Prepare a swage joint for soldering or brazing.
2. Place the female end in a vice or a flare block. Then place the flare block in a fice.
3. Clean the male end with sandpaper - be careful that none of the copper chips or abrasive gets into the tube.
4. Flux the male end ¼" only. (Flux stops the copper tube from becoming oxidated). Insert the male tube into the swage.
5. Heat the shoulder of the swage evenly, so that the solder will flow uniformly.
6. Apply soft (or silver) solder to the swage so that the solder flows around the tube.
7. Let the swaged joint cool.
8. Put the swaged joint into a fice. Cut on a diagnonal from top to bottom through the swage.
9. Clean out the chips. Use a file to mill down the burrs.
10. Repeat the above steps at least 4 times to become proficient.
11. Show it to your instructor for a grade.
12. Return all tools that you checked out of the stock room.
13. Clean up your work area.

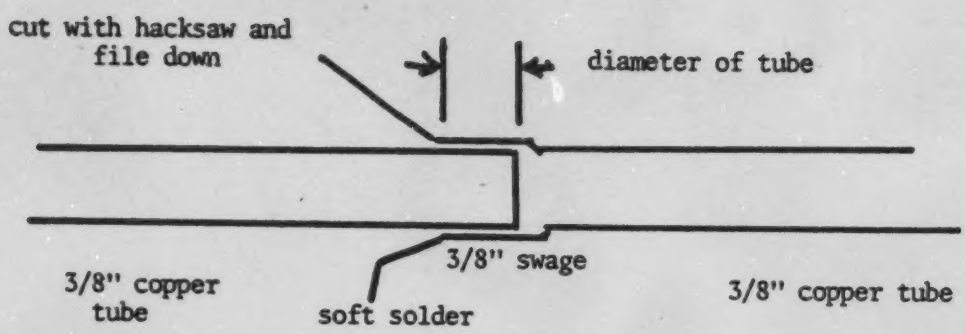


Figure 1.

Review questions:

1. What are the ingredients of soft solder?
   a. lead and tin
   b. lead and zinc
   c. tin and zinc
   d. zinc and copper

2. What are the ingredients of hard solder?
   a. tin and zinc
   b. brass and tin
   c. copper and zinc
   d. antimony and tin

3. Of what metals is silver solder made?
   a. silver, lead, zinc
   b. silver, copper, tin
   c. silver, copper, zinc
   d. nickel, tin

4. Why must the metal to be joined by solder be cleaned?
   a. to find defects
   b. to prevent burning
   c. to enable the solder to adhere
   d. to aid in heat conduction

5. What is the purpose of flux?
   a. a binder
   b. dissolving of oxides formed by heating
   c. to reduce melting temperature
   d. dissolving of dirt and grease

6. What is a good flux for hard of silver solder?
   a. tallow
   b. zinc chloride
   c. sodium chloride
   d. borax

7. How do we obtain a good soft solder joint?
   a. only solder must be heated
   b. only metal must be heated
   c. only flux must be heated
   d. heat to cherry red

8. What is meant by wiping a joint?
   a. applying oil after heating
   b. applying flux after heating
   c. building up layers of lead pipe joint
   d. wiping off excess solder after heating

9. What is meant by tinning?
   a. electroplate with tin
   b. to flux the copper
   c. to cover copper with a film of solder
   d. to fill copper defects

10. What advantage does a soldered connection have over a flared connection?
   a. easier to disassemble
   b. better refrigerant flow
   c. less expensive
   d. more leakproof

Name_____

Unit 21 - Sample Lab Project

Soldering & Brazing

Material- Two swedge connection of each size of copper, 1/4" 1/2", 5/8".
Torch, Prestolite, and Turbo.
95-5 and silflos solder, all necessary flux, cleaning tools, etc.

Procedure- Make one 95-5 solder connection on each size copper.
Cut these connections open as done last week.
ONE TRY ONLY.

Make one silflos BRAZING connection on each size copper.
Cut these in half.

Take all of these connections, and give to instructor taped to this paper.

THIS IS FOR A GRADE

Take your time and do it right the first time.

Unit 21 - Sample Lab Project

Objective

To become familiar with the proper preceedure in use of the different solders and torches used to make sweat and brazing connections.

Materials Needed

2 swedge connections of each size of copper tubing: 1/4", 3/8", 1/2", 5/8" (As made in previous lab)

One turbo torch — Swap off between other students
One prestolite torch — " " " " "
Flux and Flux brush
95-5 solder
Silflos
Sand cloth and cleaning brushes
Striker
Refrigeration wrench and Crescent wrench
Hack saw and water pump pliers

Soldering

Clean up copper properly, apply flux. Check all connections on torch for tightness. Turn on torch and light with striker. Using prestolite torch make 95-5 solder connections on each size of copper. After cooling, cut these connections diagonally with hacksaw and peel open with pliers. Pull completely apart. Show lab instructor and have him comment. Do this until good solder flow is on entire tube.
Now using turbo torch make silfloss brazing connections on each size of copper. Have lab instructor comment on these.

Lab instructor will mark you for each fitting when you feel you have a good connection.

Name_____

Unit 21 - Sample Lab Project

Lab Project

Purpose- Familiarize student with the use of the gage manifold, and service valves in use in our industry.

Materials- One manifold with hoses. (Check hose gaskets and stem depressors.) One crescent wrench. One refrigeration wrench.

Procedure- Connect gages to Bard condensing units. Have instructor check your connections. Connect to pad type. Service valve, and then to Schrader type valves.

After connecting, start unit by turning thermostat to cool. Check pressures, one should be high, one should be low. Then practice disconnecting without hoses without burning yourself.

Find different service valves around the lab and list all the different types you connect your manifold to on this page. Practice opening and closing the valves.

Name_____

Unit 21 - Sample Lab Project

OBJECTIVE: To aquaint the student with proper charging procedures, and setting of thermostat expansion valve superheat.

TOOLS NEEDED:

One testing unit (small refrigeration unit.)
Gauge Manifold
Refrigerent R12
Screwdriver
Crescent Wrench
Thermometers

PROCEDURE:

Make sure system has no leaks. Tie manifold to unit. Unit will not start until pressure is high enough to make low pressure switch. Refrigerant will not flow through entire system due to liquid line solinoid valve. Blow charge slowly on unit out high side valve only. Bring down to 5 PSIG. Start charging with unit turned off through low side. You may have to heat up tank of refrigerant.

When you hear the low pressure switch make you may turn the unit on. It may go off again due to unit low on charge. Continue charging until a clear sight glass is obtained with unit running. Now check superheat setting on expansion valve. With a clear sight glass you should maintain 10° of superheat. If not 10° adjust accordingly.

Everyone must go through setting of the expansion valve and charging of the unit.

Once unit is charged write down your highside and lowside readings, also your superheat. Then check TD across coil and record. Hand in readings on this sheet to lab instructor.

Name _____ Name _____
Student 1 Student 2

Unit 21 - Sample Lab Project

Unit # worked on _____

Unit evacuated to _____ *inches of vacuum*

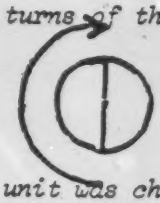
Amount of refrigerant put into Dial-A-Charge initially _____

Minus _____ *Amount left after fully charging unit.*

Equals _____ *Total Refrigerant Used.*

Super heat adjusted to _____ *Degrees.*

This took _____ *turns of the Adjusting screw from a full open position.*



one turn

The high Side Gauge Reading when unit was charged and Super Heat was set was _____ *#.*

The Low Side Reading was _____ *#.*

The suction line temperature was _____ *degrees°*

The outside ambient temperature was _____ *degrees°.*

Using the 30° over outside ambient temperature method. How close is our Reading. Within _____ *#s.*

Name _____

Unit 21 - Sample Lab Project

OBJECTIVE: To give the student a sound knowledge of proper charging procedures.

MATERIALS NEEDED:

Leak Tester
Dial-a-charge
Amana or Bard condensing unit
Refrigerator
Window unit
Tap a-line valve and torch
Vacuum pump
Manifold
Refrigerent (same as used in system)
etc.

PROCEDURE: If no service valve on system, sweat one on. Use schraeder type and schraeder access valve on manifold. Blow charge. Leak test. Evacuate. Then find out how much refrigerent system holds. Fill dial-a-charge and dial proper amount into unit. Check unit operation.

WRITE:
1. How you decided on amount of charge
2. How you filled dial-a-charge
3. How you charged unit
4. Does unit operate. (If so, give pressures)

Unit 21 - Sample Lab Project

Work Sheet #1
Refrigeration Cycle Trainer

Record the following data:

1. Compressor leaving temp _____ °F.
   Compressor leaving pressure _____ psig.

2. Condenser entering temp _____ °F.
   Condenser entering pressure _____ psig.
   Condition of refrigerant entering condenser _____.
   Condenser leaving temp _____ °F.
   Condenser leaving pressure _____ psig.
   Condition of refrigerant leaving condenser _____.
   Condenser sub-cooling _____ °F calculated.

3. Sight glass condition - clear _____ - flashing _____.
   Flashing sight glass indicates _____.

4. Evaporator entering temp _____ °F.
   Evaporator entering pressure _____ psig.
   Condition of refrigerant entering evaporator _____.
   Evaporator leaving temp _____ °F.
   Evaporator leaving pressure _____ psig.
   Condition of refrigerant leaving evaporator _____.
   Evaporator superheat _____ °F.

5. Compressor entering temp _____ °F.
   Compressor entering pressure _____ psig.
   Condition of refrigerant entering compressor _____.
   Superheat at compressor _____ °F.

6. Effect of low condenser airflow _____

   _____.

7. Effect of low evaporator airflow _____

   _____.

Unit 21 - Quiz #1

1. Read everything before doing anything.
2. Put your name in the upper right-hand corner of this page.
3. Circle the word "NAME" in sentence 2.
4. Draw 5 small squares in the upper left-hand corner of this page.
5. Put an "X" in each square.
6. Put a circle in each square.
7. Sign your name under the title of this paper.
8. After the title write: yes, yes, yes.
9. Put a circle around sentence seven.
10. Put an "X" in the lower right-hand corner of this page.
11. Draw a triangle around the "X" you just made.
12. On the back side of this paper multiply 703 x 66.
13. Draw a rectangle around the word "paper" in sentence seven.
14. LOUDLY call out your first name when you get to this point.
15. If you think you have followed directions this far, carefully call out "I have."
16. On the reverse side of this paper add: 9850 and 8905.
17. Put a square around your answer and then put a circle around the square.
18. Count in a normal speaking voice from one to ten BACKWARDS.
19. Punch 3 small holes in the top of this paper with your pencil point.
20. If you are the first person to get this far, call out loudly: "I am a leader in following directions."
21. Underline all the even numbers on this side of the paper.
22. Now that you have finished reading carefully, do only sentences one and two.

Name_____

Unit 21 - Quiz #2

DIRECTIONS: Circle T if True and F if False.

T F 1. Refrigerant may be charged either as a liquid or as a gas.

T F 2. The system is always charged either through the suction service valve or through a pinch-off tube.

T F 3. A charging manifold assembly will consist of a gauge, a manifold and three hoses.

T F 4. In a gauge manifold when both valves are "front seated" and the compressor service valves are in a mid-position, the gauges should read "high" and "low" side pressure.

T F 5. When charging by the sight glass method, the unit should be under full load conditions.

T F 6. Weighing the charge into the system is used frequently when a partial charge is required.

T F 7. Units employing thermostatice expansion valve can use the frost lane method of charging.

T F 8. The primary problem encountered when a unit is under-charged is capacity.

T F 9. "Purging" a system with refrigerant gas is considered a satisfactory drying method.

T F 10. Heat, in a concentrated form or at high temperature, should never be applied to a refrigerant bottle.

T F 11. Leaks are rarely a source of moisture entering the refrigeration system.

T F 12. The halogenated hyrocarbon refrigerants can absorb some water.

T F 13. Any system operating without "freeze-ups" is almost certain to dry.

T F 14. The biggest problem created by acids within the hermetic system is "copper plating."

T F 15. "Freeze-ups" and oil descoloration are natural moisture indicators.

T F 16. An absorbent removes moisture by chemical action.

T F 17. When using the gauge scale to read pressures below atmospheric, the higher the number the lower the pressure.

DIRECTIONS: Circle the letter in front of the correct answer.

1. The determining factor in the selection of the method of removing and storing system refrigerant is usually:

   (a) system size

   (b) economics

   (c) system valve

   (d) available space

2. When removing reusable refrigerant from a system, the line to the refrigerant storage drum must:

   (a) contain a sweat fitting

   (b) be flexible

   (c) be of copper

   (d) contain a strainer drier

3. When releasing a halogenated hydrocarbon refrigerant to the atmosphere, ample ventilation must be provided and:

   (a) as the gas is toxic, gas masks should be worn

   (b) no open flames should be permitted

   (c) explosion precautions must be taken

   (d) the owner should be informed

4. If refrigerant is removed from the system too rapidly:

   (a) it can starve the condenser

   (b) it will lower the room temperature

   (c) it may "freeze-up" the condenser

   (d) it may flood the evaporator

5. The common methods of determining proper oil change are:

   (a) dip stick, paper method and compressor sight glass

   (b) weight measurement, dip stick, liquid line sight glass and paper method

   (c) weight measurement, dip stick, pressure method and paper method

   (d) dip stick, liquid line sight glass and weight measurement

6. When charging or removing oil, three main precautions should be taken. They are:

   (a) use clean oil, watch the crankcase pressure and slightly overcharge.

   (b) use clean oil and do not overcharge.

   (c) watch the crankcase pressure and use dry oil.

   (d) use clean oil, do not overcharge and watch the crankcase pressure.

7. When charging through a suction service valve, the valve stem:

   (a) will be back seated.

   (b) will be front seated.

   (c) will be in an intermediate position.

   (d) may be front seated or in an intermediate position.

8. Hermetically sealed units are usually charged:

   (a) in the discharge line.

   (b) at the pinch-off tube.

   (c) through the liquid line.

   (d) through the discharge spud.

9. When charging through a suction manifold and compression suction service valve, the manifold valve positions would probably be as follows:

   (a) low side, front seated; high side, back seated.

   (b) low side, back seated; high side, front seated.

   (c) low side, front seated; high side, front seated.

   (d) low side back seated; high side back seated.

10. The four basic methods of determining whether the proper amount of refrigerant is being introduced into the system are:

   (a) sight glass, weight, pressure, and frost line.

   (b) bulls eye, weight, pressure, and frost line.

   (c) sight glass, weight, pressure, and dip stick.

   (d) sight glass, weight, paper method, and frost line.

11. A micron is:

    (a) one thousandth of a meter.

    (b) one millionth of a micrometer.

    (c) one millionth of a centimeter.

    (d) a small unit of measurement.

12. A wet bulb vacuum indicator records:

    (a) the temperature of the vacuum.

    (b) the pressure of the vacuum.

    (c) the temperature of boiling water.

    (d) condesate temperature.

13. Refrigeration compressors:

    (a) may be used as vacuum pumps.

    (b) should never be used as a vacuum.

    (c) may have insulation deterioration when used as vacuum pumps.

    (d) are a good dehydrator.

14. When heat is added to a system being dehydrated by evacuation:

    (a) the temperature pressure relationship of water is changed.

    (b) a pressure of below 100 microns is still required to dehydrate.

    (c) the high vacuum requirements for dehydration are reduced.

    (d) the oil will boil.

15. A vacuum pump used in dehydration by triple evacuation should be capable of creating a vacuum of approximately:

    (a) 5000 microns.

    (b) 100 microns.

    (c) .004" abs.

    (d) 500 microns

16. Nitrogen is sometimes used to break the first vacuum in dehydration by double evacuation; however:

    (a) it is often wet.

    (b) it is expensive.

    (c) it may be dangerous.

    (d) it is a toxic gas.

17. Of all the halogenated hydrocarbons, R-11 is most often used for cleaning because:

    (a) it is a good solvent.

    (b) it will absorb some moisture.

    (c) it is inexpensive.

    (d) it is easy to handle.

18. When using a liquid refrigerant flush in cleaning the system, the metering device:

    (a) must be removed.

    (b) must be in a condition to assure liquid flow.

    (c) must be bypassed.

    (d) must be closed.

19. When using a system cleaner, the heat source must be:

    (a) from the compressor.

    (b) from an external source.

    (c) rigidly controlled.

    (d) at low temperatures.

Name 298

1. When cutting tubing with a hacksaw, what precautions must be taken?
   A. keep chips from falling inside tube
   B. not to cut tubing to quickly
   C. use oil when cutting tubing
   D. cut tubing square

2. Annealing copper is the term used when hardening copper. (True or False)

3. Refrigeration tubing is refered to by its I.D. (True or False)

4. A single flare can easily be made into a double flare, without cutting the tubing. (True or False)

5. Sealing compound should not be used with a flare type connection. (True or False)

6. Soldering is a process of applying molten metal to metals that are_____.
   A. ferrous
   B. molten
   C. heated
   D. ready

7. A good sweat joint begins with first _____ the parts.
   A. reaming
   B. soldering
   C. fluxing
   D. cleaning

8. 95/5 solder is mainly composed of:
   A. tin
   B. silver
   C. lead
   D. antimony
   E. all the above

9. What is the melting temp of 95/5?
   A. 125°F
   B. 570°F
   C. 1190°F
   D. 1500°F

10. What type of connection is silver brazing used for that 95/5 and Sil-Flos won't work on.
   A. copper to copper
   B. copper to brass
   C. copper to steel
   D. copper to aluminum

11. What temperature can silver brazing be done at?
   A. 125°
   B. 570°
   C. 1145°
   D. 6300°

12. What type of flux should be used with Sil-Flos?
    A. nokrode
    B. stay-brite
    C. silver brazing flux
    D. copper to aluminum
    E. none of the above

13. What torch can be used for Sil-Flos?
    A. prestolite torch
    B. turbo-torch
    C. oxy-acetylene
    D. all the above

14. What position should the regulator be adjusted to on a Prestolite torch if using turbo tip?
    A. all the way out
    B. mid-position
    C. all the way in
    D. none of the above

15. How often should your acetylene or oxygen regulator be oiled?
    A. once a year
    B. twice a year
    C. depends on the amount of use
    D. never

16. You always should pull a wrench. (True or False)

17. When using a oxy-acetylene torch what type of flame is best to use for brazing?
    A. neutral flame
    B. oxidizing flame
    C. reducing flame
    D. none of the above

18. Gravity plays an important part of the soldering process. (True or False)

19. When using the kit to solder aluminum what tells you when the metal is at the proper temperature?
    A. when the flux "spots"
    B. when the metal melts
    C. when the metal changes color
    D. all the above

20. The filler rod should be applied to the opposite side of the tubing or fitting than the heat is being applied. (True or False)

21. The best tool for cutting copper tubing is a _____ _____.

22 A _____ should be used to remove any burrs left on inside of copper tubing.

23. Heavy walled tubing should be cut with a _____ _____.

24. A flaring tool consists of two parts, namely, the _____ and the _____.

25. When making a flare, it is important to remember to place the _____ _____ on the tubing before flaring it.

26. There are bending springs for bending copper that fit over the outside, and also some fit inside. T or F

27. Removal of a bending spring is made easier if the bend is make _____ _____.

28. Most flare fittings are made of _____.

29. When swedging a piece of copper, the copper should extend out of the holding block _____.

30. When soldering with a 95-5 solder, the copper tubing must be prepared. How is this done? Go through entire procedure.

_____

_____

_____

31. What takes place if copper is overheated? _____

32. It is advisable to purge a system with _____ _____ while sweating the solder connection.

33. If the solder joint has been heated properly, capillary action will draw the solder into the joint. T or F

34. 95-5 solder is 95% _____, 5% _____ and melts at _____°.

35. Sil-Flos is made up of _____% silver Aloys, and melts at ____° flowing free at _____°.

36. Silver solder is about _____% silver and flows at _____°.

37. Only one of these three solders should be used on a steel to copper connection. Which one is it? Circle one.

95-5 Silver solder Sil-Flos

38. Why is it not necessary to clean copper that is to be Sil-Flossed?

_____

_____

39. Is a flux necessary when using silver solder? _____

40. Is a turbo torch hotter than a turner torch? _____

41. Soft copper tubing becomes softer the more it is worked. T or F

42. What is ACR tubing?

_____

43. Hard copper tubing can be bent around 90° corners easily by heating it. T or F

44. We use nominal size copper tubing in our refrigeration systems. T or F

45. When flaring tubing, the tube must not extend above the block. T or F

46. We use 95-5 solder because it can take very low temperatures. T or F

47. When buying silver solder look for a brand that does not contain any _____ The fumes created by this are poisonous.

48. When using flux for _____, _____; the flux will turn to a clear liquid at a temperature just below brazing point.

49. When swaging copper tubing, the length of the overlap of the two pieces should be equal to the _____ _____ of the tubing.

50. When flaring copper the tubing end should be cut off squarely. T or F

51. When tightening the wing nut on a flaring tool you should tighten the nut furthest from the tubing first. T or F

52. Using a 3/4" piece of copper describe a step-by-step procedure of swaging the copper.

53. Describe a step-by-step process of double flaring a piece of 1/2" copper.

54. Describe in a step-by-step process soldering with:

95-5 solder

Sil Flos

Silver Solder

(T) (F) 55. The ridges in the flare block are made to thread the tubing near the flare.

(T) (F) 56. The flare yoke is made for sealing tubing ends.

(T) (F) 57. The copper tube will be dirt free if we seal the open ends.

(T) (F) 58. Reaming is important because it removes the excess copper that ordinarily would cause leaks.

(T) (F) 59. The pie edged condition on copper tube that has been reamed is caused by bad reaming equipment.

(T) (F) 60. When reaming the inside ridge of copper tubing the working end should be held upward in full view.

(T) (F) 61. Because flare tools and pipe cutters are reasonable in price extraordinary care of these tools need not be taken.

(T) (F) 62. When cutting copper tube with a hacksaw, the tube can be cut square and the chip can be allowed to fall into the tubing used.

(T) (F) 63. The inside diameter of ¼-inch tubing is 3/16 of an inch.

(T) (F) 64. The tube is cut square with the tube cutter to make it easy to ream.

(T) (F) 65. Refrigeration solder is 90% lead and 10% zinc.

(T) (F) 66. When swedging, thinning the copper removes dirt and impurities.

(T) (F) 67. When swedging, it is not necessary to ream the swedged tube.

(T) (F) 68. Flux in the swedged fitting helps make a strong durable union.

(T) (F) 69. Swedged fitting eliminates many flare nuts and fittings.

(T) (F) 70. A swedged union is stronger than the tube itself.

(T) (F) 71. For a swedge union in refrigeration, acid flux is permissable.

(T) (F) 72. The tinning of copper is accomplished as follows:
1. Remove the oxide with a scratch brush or sandpaper
2. Heat the copper
3. Immerse the tube in flux
4. Apply solder for about ½" from point.
5. Wipe the joint with a piece of burlap or rag.

(T) (F) 73. If sandpaper is not available, emery cloth may be used for cleaning tubing.

74. Of what metals is silver solder made?
a. Silver, lead, zinc.
b. Silver, copper, tin.
c. Silver, copper, zinc.
d. Nickel, tin.

75. What is the purpose of flux?
a. A binder
b. Dissolving of oxides formed by heating.
c. To reduce melting temperature
d. Dissolving of dirt and grease.

76. What is a good flux for hard or silver solder?
a. Tallow.
b. Zinc shloride.
c. Sodium chloride.
d. Borax

77. How do we obtain a good soft-solder joint?
a. Only solder must be heated.
b. Only metal must be heated.
c. Only flux must be heated.
d. Heat to cherry red.

78. What is meant by tinning?
a. Electroplate with tin.
b. To flux with copper.
c. To cover copper with a film of solder.
d. To fill copper defects.

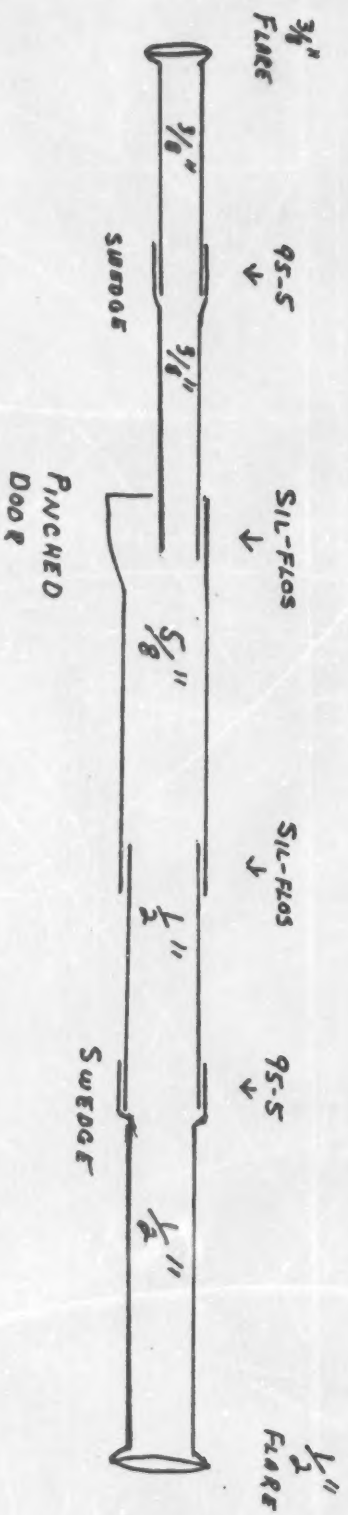
79. What advantages does a soldered connection have over a flared connection? Choose any that apply:
   a. Easier to disassemble.
   b. Better refrigerant flow.
   c. Less expensive.
   d. More leakproof.

10

Unit 21 - Quiz #3

3" LENGTHS OF COPPER
4" " OF 5/8" "

1 - 1/2" FLARE NUT
1 - 3/8" FLARE NUT



11

AREA - REFRIGERATION SERVICE PROCEDURES

Unit 22 - Service Procedures Advanced

I. Instructional Objectives
To instruct the student in the proper use of gauges and meters used to diagnose problems in air conditioning equipment. Instruction safety precautions. Emphasis is on basic problems that arise in residential air conditioning systems and procedures followed in correcting them.

II. Reference Materials
Refrigeration and Air Conditioning, all, 8, 10, 22, 23, 24, 25
RSES Sam-43, 3
Refrigerants and Service Pointers Manual
Modern Refrigeration and Air Conditioning 11
Carrier GTR Book 16

III. Visual Aids
Slides, Carrier GTR-16
Overheads of Compressor Change and Procedures
Carrier or equivalent Troubleshooters Guide Wheel
A'B'C Burnout Copeland

IV. Method Performance Conditions
Given several different makes and models of domestic air conditioning equipment and P.H. charts - simulated service problems in refrigeration circuits will be created.

V. Outline

1. Compressor
   A. Functions
   B. Problems arising
   C. Valves
   D. Lubrication
   E. Liquid slugging
2. Condensor
   A. Functions
   B. Problems arising
3. Metering device

A. Different types

B. Function

C. Troubleshooting problems that arise

D. Sizing for replacement

4. Evaporator Coil

A. Function

B. Problems arising

5. Piping

A. Proper methods

B. Repair of leaks

6. Review of use of gauges and leak detection and charging equipment

7. PH charts

A. Uses in HVACS field

B. Plotting systems on chart

C. Diagnosis of problem from chart

8. Domestic window A/C

A. How their servicing differs from central systems

9. Domestic refrigerators and freezers

A. Explain specialized area

B. Complications in servicing

C. How to service

VI. Student Evaluation Parameters

Student will demonstrate service procedures on many different types of systems. Use of PH chart will show students diagnosis of immediate problem capability. Timing of problem solving lab tests will teach students step by step service procedures to solve problems in the shortest possible amount of time. Student will be capable of solving refrigeration circuit problems through a set service procedure.

VII. Sequence of Instruction

1. Read all reference materials
2. View visual aids.
3. Discuss all components and service procedure steps.
4. Develop lab example service calls.
5. Have student correct problems using set service procedure and PH charts - timed.
6. Do unit tests.

Unit 22 - Sample Outline to use with Carrier Slides and Book

TROUBLE SHOOTING

1. Deals with components of Ret. cycle.
2. Major items to be covered
   A. READ SLIDE
3. Trouble shooting not hard-
   A. Equipment will do BEST it can to indicate what's wrong
      (1) belt squeak
      (2) valve chatter
      (3) leak hiss - or oil spot
      (4) motor smoke
   B. Each condition says HELP
   C. Merely recognize symptoms and properly interpret them.
4. Air cooled condenser
   A. Most common disease (high head pressure)

      Most frequent causes

      READ BOOK
5. Water Cooled problems
   A. Not as easy to diagnose
   B. Water controlled by flow valve
   C. Condition that cause rise in head pres.-air cooled (just increase water flow in water condensor)
6. Following problems will not increase head pres.-to maximum water flow is reached.
   A. Condensor drowning before symptoms show
   B. Customer will complain - high water costs first
   C. READ BOOK

7. Cooling Tower - or other fixed rate
   A. Same symptoms air cooled
   B. Air in system
      Overcharge
      Scale in tubes = high head pres.
   C. Comp. stop H.P.S. - motor overload
   D. Added to that - tower fan failure - pump failure - plugged screens same thing
8. Evaporative condensors
   A. Use both air and water
   B. Behavior - more like air cooled
   C. Causes - READ BOOK
   D. Entering wet bulb controls capacity
9. Review - two groups - read slide
   A. First group - water cooled - valve
      (1) will not show high head as symptom
      (2) increase water use
   B. Air - Evap. - cooling towers
      (1) air and/or water vol. constant
         (a) first symptom loss efficiency
   C. Sometime this group has
      Dampers
      Bypass valves
      Fan speed control
      This is for ambient control - will not help plugged condensors

10. Vortexing

    A. Receiver - storage tank

    B. Very little problem

    C. Vortexing - like bathtub drain

       Gas - Liq. - at outlet

    D. Reduces capacity at expansion valve

    E. Spotted by - gas in sight glass

    F. Vortexing greater in bottom outlet receiver

    G. Restrict could give same condition

       No matter how much ref. added problem would not correct

11. Evaporator

    A. Problem - diagnosis depends on the medium being cooled

    B. We will divide evap. into two groups

       (1) cooling air

       (2) cooling liquid

    C. First group

       (1) Bare - Finn - Plate coils

           forced air or gravity

       (2) Category #1 - DX - Cap. tube

    D. Second group

       (1) flooded + DX chillers and plate type contact coolers

       (2) E-V or low side float

12. Evap. - cooling air

    A. Two trouble areas

       READ SLIDE

13. Fan Adj. clear all problems

A. Air shortage can be caused by

READ BOOK

B. Symptoms of low air are

READ BOOK

C. High air rare (noise - poor humidity control - comp. overload

14. Air distribution - poor

A. Caused by improper duct work or coil placement

B. Air takes path of least resistance-
Turbulance causes resistance-
This can change air path

C. Uneven air distribution will be evident by

READ BOOK

D. Duct vains correct problem

15. Refrigerant shortage caused by:

READ BOOK

Shortage

A. Addition of ref. should raise suction-clear frosting and clear sight glass

B. Restriction exists temp. drop at restriction will persist until cleared-in spite of more ref.

C. Ref. charge ample-no restriction exists-yet low suction and high superheat Look for faulty ex-valve or improper bulb application

16. Distribution

A. A sick distributor can't do the job - Poor distribution to the coil - It can be caused by -

READ BOOK

B. Air-Flow should be even before you say a distributo is bad -

Same symptoms

17. Chillers

A. Problems - same - Dx or flooded

B. Reasonable load to keep it operating comfortably

C. Storage of water quantity will result in lack of capacity

Symptoms

READ BOOK

D. Check pump pres

Low suction pres

Chiller piping

18. Short of Gas - Lack-of-capacity

Low temp. drop Low suction pres.

Safety thermostat cut out

Cause

READ BOOK

19. Open & Hermetic compressors

A. Problems are common

20. Basic Problems -

A. Electrical problems not considered

B. Common to both

Mechanical seizure

Noise

Failure to pump properly

Overheating

C. This one has them all

21. Seizure

A. First determine cause before repairing

B. Factory defects can show any time - but usually appear shortly after startup.

C. Seizure cause by oil

READ BOOK

D. Oil charge normal or seized

hermetic - mechanically defective

E. Seizure usually result of burn out and not cause

F. Open compressor - tear down check quantity of oil in

crank case

22. Noisy

A. Lack of oil

B. Noise can be caused by the same condition

that cause seizure

C. Rattling at startup (slugging)

23. Pumping Capacity

A. High suction Low head

B. Close suction valve - 15" to 25"

C. Close discharge - stopping-equip-

pressure should not drop 3 or 4 lbs.

D. No valves depend on temp. tap line valves

24. Over heating

A cause of compressor over heating

READ BOOK

25. Basic controls

A. These tie directly into system.

26. Expansion Valve

A. Flooding - valve sticking open

B. Starving - Valve sticking closed - or bulb charge

C. Hunting - Nature - Sticking Parts

READ BOOK

27. Cap-Tubes

A. Simple in themselves

B. Hard to diagnose

C. Valve pressure drop through orfice

D. Cap Tube - drop through entire length

E. Only - malfunction - partially or all the way plugged

F. Other problems blamed on cap tubes

READ BOOK

G. Can pass more liq. than gas -

at given pres.

H. Sensitive - to oil - excess sub

cooling - or flashing

I. Oil displaces ref. starves coil

J. Sub-cooling cuts flashing floods

K. Excessive flashing reduce liq-starves

28. Other types

A. Problems obvious (Flooding - starving)

B. Still have leaking

29. Low-high pres.

A. Automatic reset (Nuisance trip)

B. Most common low pres (Slow E.V.)

C. High pressure (comp. comes up faster than

fan. Can clear heat)

D. Fuse-Low current (across term.)

30. Accessories

A. Dryer

B. Can release moisture 70° - 100°

C. Dryer saturated at 70°

D. Moisture will not plug

E. Partial plug no temp. D.F.

F. Loss capacity (Cap tube)

31. Solenoid

A. Hum

1. Low voltage

2. Loose connection

3. Sticking plunger

B. Fail to open

1. Sticking

2. Open coil

3. Excessive pres. diff.

a. Check operating press diff.

before concluding valve is stuck

C. Leakage - temp drop across valve.

32. Water Control

A. May stick or fail to shut off.

B. High water costs may be

READ BOOK

C. Require 10 to 20# diff off

33. Sight glass

Materials needed

Simpson 260 meter

Object- To become familiar with the use of meters in servicing.

Procedure- List name and serial no. of units worked on.

1. All readings will be resistance readings, be sure power is off at units disconnect.
2. Remove wiring from compressor
3. Take resistance readings on two compressors. One good and one bad.
4. Determine at the compressor, without the wiring diagram, the position of Start, Run, and Common terminals. Use RX1 scale.
5. Check compressor for being grounded. Use RX10,000 scale.
6. Check run capacitors on R 10,000 for ability to charge and discharge.
7. Use RX10,000 scale, check from terminals to side of capacitor case for a grounded unit.
8. Capacitor mounted on component board with expanded case. Check out this capacitor also.
9. Record all reading.

Unit 22 - Sample Lab

Materials:

1. Simpson 260 meter
2. Amprobe

Object:

To become familiar with using meters for servicing

Procedure:

1. Check at BARD condensing unit with blown compressor. Read locked rotor amps., with amprobe. Atthe same time check voltage drop across the line with 260 meter.
2. Disconnect unit while changing check positions, BE SURE METER IS ON HIGH ENOUGH RANGE, to protect meter.
3. Make the same chech as in #1 on a run able unit.
4. Make both checks over again on a 110v. unit. One of the window air conditioner or the refrigerator. If compressor is not bad, simulate condition by running up pressure, turn unit off and back on befor it can equalize.
5. Record read on all four tests, along with identification of unit used.
6. Return meters (260) set on AC 1000, and AMPROBE with lock set. Replace all wiring as it was, and all panels in place.

Unit 22 - Sample Lab

Purpose: to attempt to show how a compressor operates in a refrigeration system by having the student examine various compressors and components.

Lab Assistant Initial Here

1. Be able to identify (where available)
    1. open compressor
    2. semi-hermetic (Copeland)
    3. semi hermetic (G.E.)
    4. semi hermetic (Dunham Bush)
    5. other units as available
2. On a semi-hermetic identify:
    1. terminals
    2. valve plate
    3. suction and discharge services valves
3. Using the Copeland unit with the condenser in the storage freezer as an example or text on lecture, draw a diagram of a hot gas by pass system.

4. Take apart (and reassemble) a compressor in the lab. Be able to show familiarization with components.

    Lab assistant initial _____

5. Set a pressure control using gauges to various settings.
6. If time permits take apart a water valve.
7. If time permits take a condenser or evaporator fan motor off, and replace in order to gain working experience.

Unit 22 - Sample Lab

Evaporators and Condensers

Purpose: To briefly introduce a student to the operation of evaporators and condensers relating their functions to the operation of a typical refrigeration system.

Lab Assistant Initial

1. Using a water cooled unit explain the water flow, in particular the counterflow principle.

2. Explain the operation of a water valve.

3. Take an operating unit, install gauges, record pressures, with normal operation and with condenser ¼, ½, 3/4 and fully blocked. Record pressures, high and low.

4. While doing the above, record the amp. Explain the relationship of presure to amp.

5. Check the temperatures of entering and leaving air on a condenser, relate to pressure.

6. Same as above, on an evaporator.

Unit 22 - Sample Lab

It may be necessary to use more than one Lab.

Purpose: To provide a practical knowledge of Refrigeration metering devices, in particular, the Thermostatic Expansion Valve (T.E.V.) and the cap tube.

Sources: Text Trane chapter IX and supplimental material.

Teams: Because of usable equipment, it may be necessary to team up in crews of 2 or more.

Tools: Refrigeration service valve wrench, Refrigeration gages (compound & pressure), charging lines, adjustable wrenches and other tools as needed, also thermometers and clamps.

Use trainers or other operative units

I. T.E.V.

A. Install gages record pressures.

B. Install thermometer on outlet of Evap at T.E.V. bulb. Record temperature.

C. Remove T.E.V. bulb; wait approximately 3 min. What are temperature and pressure now?

D. Why have they changed?

E. Reattach T.E.V. bulb.

F. Using Sporland T.E.V. adj. chart and P.T. chart, adjust Superheat to 10°. (With Sporland chart disregard Suction line drop if very close coupled. or use external equalizer tube for Evap. outlet pressure.)

G. What is effect of suction line drop. Is 4# p.s.i. instead of the estimated 2#?

H. Using a Cond unit that can be pumped down, pump down unit. Remove T.E.V. Replace and put back in operation.

II. Cap Tubes

A. Install gages, record pressures.

B. Install thermometer at outlet of Evap; record temperature.

C. Add small amount of correct refrig. What does this do to pressures and superheat.

D. Release some refrig (System short of gas). What does this do to temperature and pressure.

E. Recharge - (approx head 30° over air temp) Check cond temperatures and superheat and suction press.

NAME_____

Purpose: There are many different types of controls that are used in various ways by manufacturers and installers. A person in the refrigeration field should be aware of these methods of controlling refrigeration equipment.

Safety: The C.O.D. lab has various units for a student to work on. Please remember proper safety procedures. Do Not touch a wire unless you know it is not live. Use a Tester. When shutting off switches, tag it so no one turns it on. If you have questions on safety, ask the lab asst.

Verification: Please have lab asst. initial EACH project as completed.

1. On a system using a Hi - Low pressure control - using gages.
   a. check the Hi - Press cut out.
      1. What is it set at?

      2. Is it a correct setting?

   b. What is the low press setting?
      Change it. Then readjust it.

2. Locate a bi metalic thermostat with a mercury bulb on a residential A.C. Is this a operating or safety control? explain.

3. Remove the above thermostat, reinstall it. Check to see if it is level.

4. On a unit with a starter, trace the wiring through the OL's.

5. Take the starter off and examine the method of overloads and heaters.

6. On a unit with a "Klixon" O.L. show a diagram how it is wired into the system.

   a. Dunham Bush Comp on Dual Jet.

   b. Cope comp with klixon in series with contactor coil.

6. c. Residental A.C.

7. Using a clam on meter (Amprobe) find an operational unit and check
   a. amps on starting

   b. disconnect comp check for grounded compressor.

   c. check for open windings

   d. is the unit properly wired and fused?

8. Using a defective comp check b and c above.

9. Be able to show the difference between
   a. cartage fuses

   b. plug fuses

10. Be able to show methods of detecting blown fuses using line voltage.

11. Be able to check fuses using continuity.

12. What is a "dual" element fuse?

Unit 22 - Sample Lab

Read thoroughly

Lab 6 - Compressor change, and Condenser fan changes

Background: Continue to work on other lab assignments until they are completed. Due to lack of equipment or other problems, it may be necessary to start a later assignment before a previous one is completed.

As Work is Done Have Lab Assistant Sign Each Item.

I. Compressor. In teams of two or more, remove a hermetic Compressor from one of the Bard A.C. units. Please follow good refrigeration safety practices, discharging refrig, removing compressor, etc. Take your comp and exchange it with another team. (Check first to be sure compressors are the same) Install and recharge.

Work completed _____

Signature

II. Condenser Fan. As in above exercise, remove condenser fan motor and reinstall.

Work completed _____

Signature

The above two exercises should give you practicle experience doing every-day types of service work.

III. If there are any questions, think about what you are doing. Ask Lab Assistant.

It is important to complete any work started on that night since other classes also have to use the units.

IV. Write a paragraph or two about problems you had or knowldege you absorbed.

I. Time: this Lab will continue until equip. is operational

II. Purpose: to give the student a working knowledge of various refrigeration procedures pertaining to the insulation and start up of refrigeration units (including soldering, sil flos, hanging and cutting tubing, evacuation, start up and charging).

III. Background: In the Lab there are certain units that have been disconnected to facilitate other trades. These units should be put back into operational use.

IV. Sources: other courses, lecture and Trane Chapter 17,18,19,20,21

V. Plan: Plan the material to be used, put aside and make with project. Plan so you have material for use the following week.

VI. Supervision: Lab asst. will help organize work and check progress.

VII. All work shall be done in a workman-like manner. All pipe will be hung securely and will be Plume and Straight.

VIII. Use the back of this sheet to detail your plans. List parts used. Briefly tell what you have done. In conclusion, relate what you have learned.

IX. Safety: goggles will be worn while soldering or sil-flosing.

FOR FURTHER INFORMATION, CONSULT ME OR ASK LAB ASSISTANT.

Unit 22 - Quiz #1

Name_____

AIR CONDITIONING

1. The refrigerant absorbs latent heat from the area to be cooled.
   A. true
   B. false

2. How long does it take for 3000 lb of ice to melt if it absorbs 288,000 BTU in 24 hr?
   A. 24 hr
   B. 48 hr
   C. 72 hr
   D. 36 hr

3. Ice always melts at the same temperature.
   A. true
   B. false

4. If the pressure over a liquid is lowered, the liquid will boil at
   A. a higher temperature
   B. a lower temperature
   C. the same temperature
   D. depends on the amount of liquid

5. What is the maximum number of BTU's an air conditioner rated at 1.5 tons can remove in one hour?
   A. 432,000
   B. 12,000
   C. 18,000
   D. 36,000

6. An air conditioner capable of removing 48,000 BTU in one hour has a rating of_____tons.

7. On which of the following latent heats is the principle of the mechanical refrigerator based?
   A. melting
   B. fusion
   C. vaporization
   D. condensation

8. Which change of state is occurring when the refrigerant is changing from a liquid to a vapor?
   A. liquid to solid
   B. solid to liquid
   C. liquid to gas
   D. gas to liquid

9. Temperature and heat are the same thing.
   A. true
   B. false

10. Heat is
    A. the number of molecules in the substance plus the speed of the molecules
    B. the speed of the molecules
    C. the speed of the molecules plus the weight of the substance
    D. the speed of one molecule times the number of molecules

11. A gallon of water at 200°F contains more heat than 2 gallons of water at 180°F.

    A. True
    B. False

12. Thermometers are used to measure heat.

    A. True
    B. False

13. Which of the following is used to register very high temperatures?

    A. glass tube thermometers
    B. thermostats
    C. acrometers
    D. pyrometers

14. Most thermostats operate on the principle of:

    A. expansion of mercury or alcohol
    B. expansion and contraction of dissimilar metals
    C. flow of a small electrical current

15. Which of the following scales places the freezing point of water at 0°?

    A. Centigrade
    B. Centigrade absolute
    C. Fahrenheit
    D. Fahrenheit absolute
    E. Weaver standard

16. The absolute Centigrade scale is called the:

    A. Kelvin scale
    B. Rankin scale
    C. Fahrenheit scale
    D. none of these

17. Which of the following scales places absolute zero at -460°?

    A. Fahrenheit absolute
    B. Centigrade absolute
    C. Fahrenheit
    D. Centigrade

18. Which of the following scales places absolute zero at 0°?

    A. Fahrenheit
    B. Centigrade
    C. Kelvin

19. A liquid refrigerant that boils at -21 F will continue to boil when the surrounding air is at 30 F, provided the pressure remains the same.

A. True
B. False

20. If an evaporator coil were kept at the same temperature and pressure as a tank of liquid refrigerant, very little evaporation would take place when the liquid was metered from the tank into the coil.

A. True
B. False

21. Which of the following would most logically be called an evaporator?

A. a refrigerant
B. a coil
C. a condenser
D. a liquid receiver

22. Which of the following would be called the metering device?

A. refrigerant
B. condenser
C. coil
D. hand valve

23. A liquid can be heated above its boiling temperature for a given pressure by adding large quantities of heat.

A. True
B. False

24. The capillary tube in the system performs the function of:

A. evaporating the liquid refrigerant
B. condensing the liquid refrigerant
C. reducing the pressure of the liquid refrigerant
D. increasing the pressure on the liquid refrigerant

25. The evaporator is a

A. high-pressure component
B. low-pressure component
C. low and high-pressure component
D. none of these

26. The two components that contain coils are

A. the compressor
B. the evaporator
C. the condenser
D. the capillary tube
E. the suction line
F. the liquid refrigerant line

27. The compressor performs the function of

A. compressing the liquid refrigerant to a higher pressure
B. compressing the vaporized refrigerant to a liquid
C. compressing the vaporized refrigerant to a gas at a higher pressure
D. compressing the liquid refrigerant to a gas
E. none of these

28. The evaporator performs the function of

A. evaporating the liquid refrigerant to a high-pressure gas
B. evaporating the liquid refrigerant to a low-pressure gas
C. evaporating the low-pressure gas to a higher-pressure gas
D. evaporating the high-pressure gas to a lower-pressure gas

29. The condenser performs the function of

A. condensing the liquid refrigerant to a higher pressure
B. condensing the liquid refrigerant to a low-pressure gas
C. condensing the vaporized refrigerant to a low-pressure liquid
D. condensing the vaporized refrigerant to a low-pressure gas
E. none of these

30. The refrigerant gives up its absorbed heat in

A. the evaporator section
B. the condenser section
C. the compressor section
D. the capillary tube section
E. none of these

31. The refrigerant picks up heat from the area to be cooled in

A. the evaporator section
B. the condenser section
C. the compressor section
D. the capillary tube section
E. none of these

32. The two components that have both a high-pressure side and a low-pressure side are:

A. the capillary tube
B. the suction line
C. the compressor
D. the condenser
E. the evaporator
F. the liquid refrigerant line

33. A refrigerant picks up heat and then gives up its absorbed heat as it circulates through the system.

A. True
B. False

34. Which of the following refrigerants is water?

A. R-11
B. R-12
C. R-22
D. R-717
E. R-718
F. None of these

35. The main advantage of using a refrigerant having a low condensing pressure is that:

A. equipment costs can be lower
B. less refrigerant is necessary
C. leaks will not develop
D. leaks can be detected without danger

36. Which of the following is a thermodynamic property of refrigerants?

A. odor
B. leakage tendency
C. moisture reaction
D. enthalpy
E. flammability

37. Which of the following refrigerants has the greatest specific volume as a vapor?

A. R-11
B. R-12
C. R-22
D. R-717
E. R-718

38. Which refrigerant listed has the lowest boiling temperature at atmospheric pressure?

A. R-11
B. R-12
C. R-22
D. R-717
E. R-718

39. Which refrigerant listed has the greatest toxicity?

A. R-11
B. R-12
C. R-22
D. R-717
E. R-718

40. On which of the following refrigerants would the halide leak test be used on?

A. R-11
B. R-717
C. R-718
D. none of these

41. Which of the following is the most flammable?

A. R-11
B. R-22
C. R-717
D. R-718
E. all are equally flammable

42. The horizontal scale shown on the basic refrigerant diagram (Fig. 12-1) is a measure of:

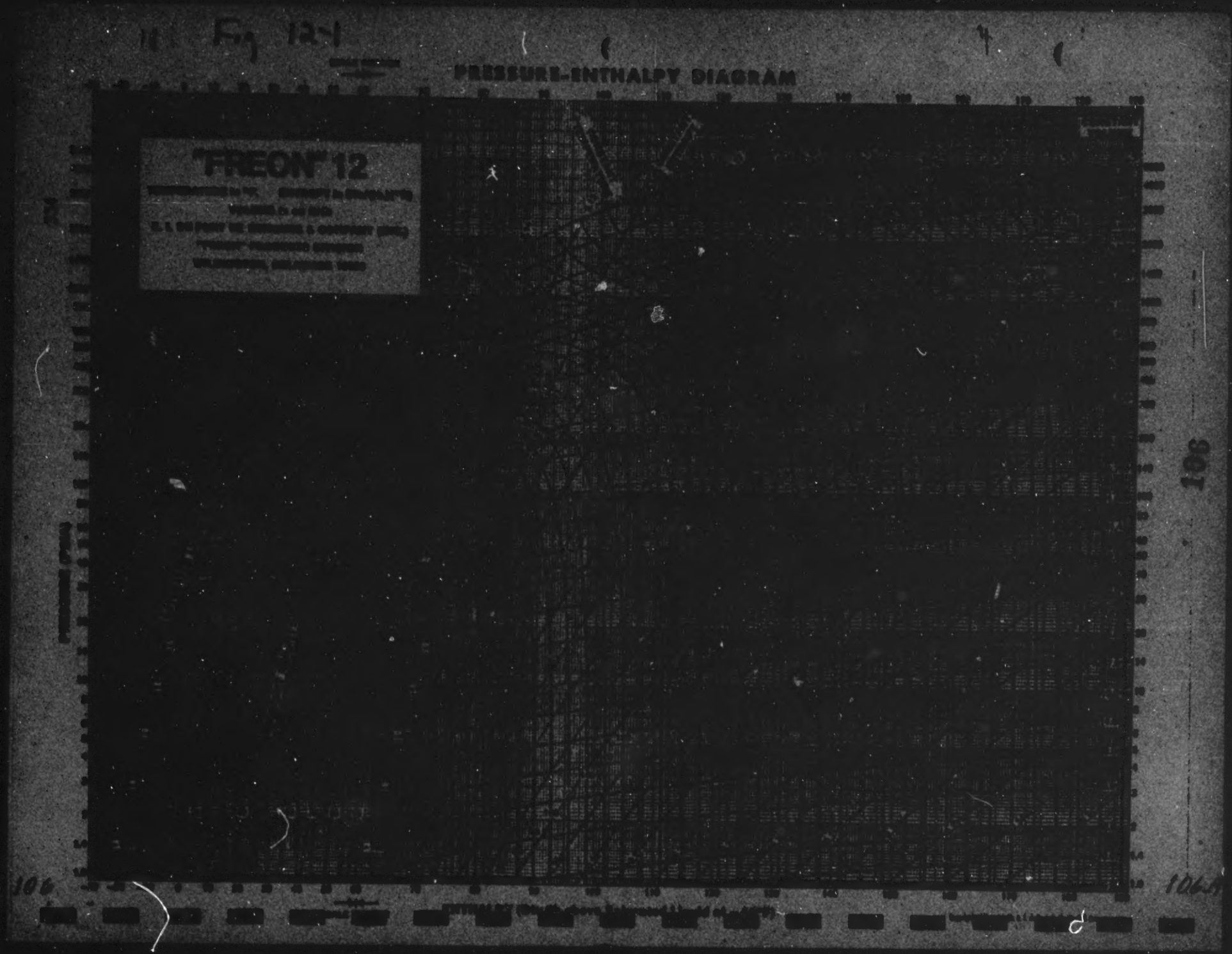
A. temperature
B. pressure
C. heat
D. enthalpy

43. The vertical scale on the chart (Fig 12-1) is a measure of

A. temperature
B. pressure
C. heat
D. enthalpy

44. The area to the left of the saturated liquid curve (fig. 12-1) shows how the refrigerant behaved in the

A. liquid state
B. vapor state
C. vapor and liquid states
D. none of these


PRESSURE-ENTHALPY DIAGRAM
"FREON" 12

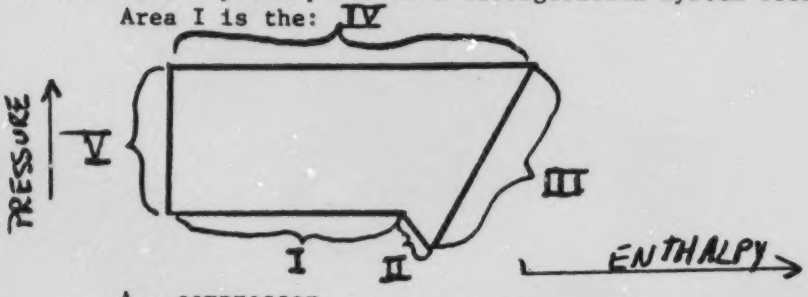
45. The area inside the curve of Fig. 12-1 (between the saturated liquid line and the saturated vapor line) is NOT which of the following?

A. the area of latent heat
B. the area of part vapor and part liquid
C. the area of critical temperature
D. a measure of cooling potential

46. Five percent (5%) constant quality means:

A. the refrigerant is 5% free of impurities
B. the refirgerant is a 5% vapor
C. the refrigerant is 5% liquid
D. the refrigerant is 5% heat laden

47. Identify the parts of a refrigeration system from the accompanying diagram. Area I is the:



A. compressor
B. condenser
C. capillary tube
D. evaporator
E. suction line

48. Area II is the:

A. compressor
B. condenser
C. capillary tube
D. evaporator
E. suction line

49. Area III is the

A. compressor
B. condenser
C. capillary tube
D. evaporator
E. suction line

50. Area IV is the

A. compressor
B. condenser
C. capillary tube
D. evaporator
E. suction line

51. Area V is the

A. compressor
B. condenser
C. capillary tube
D. evaporator
E. suction line

52. The most commonly used compressor type for domestic equipment is

A. hermetic reciprocating
B. open reciprocating
C. hermetic rotary
D. open rotary

53. Which of the following connections is used to evacuate the system?

A. suction connection
B. process connection
C. discharge connection
D. none of these

54. The metering device most commonly used on domestic systems is

A. capillary tube
B. automatic expansion valve
C. thermostatic expansion valve
D. none of these

55. A system that uses only one evaporator as the freezer compartment to cool both freezer and fresh foods compartments is

A. cold air spillover
B. secondary refrigerant
C. combination evaporator
D. forced-air evaporator

56. Which of the following evaporators is used by a frost-free refrigerator-freezer?

A. cold air spillover
B. secondary refrigerant
C. combination evaporator
D. forced-air evaporator

57. The chest-type freezer most often has the evaporator coils located

A. on the outer walls of the freezer
B. on the inner walls of the interior freezer
C. on the back of the cabinet
D. in the compressor compartment

58. Which of the following is usually called a convection condenser?

A. finned
B. wire
C. skin
D. none of these

59. Which of the following condensers is the most difficult to repair?

A. skin
B. wire
C. fin
D. bare coil

60. Which of the following acts as a reservoir for liquid refrigerant?

A. accumulator
B. storage chamber
C. filter-drier
D. heat exchanger
E. None of these

61. In which of the following are the capillary tube and the suction line soldered together?

A. accumulator
B. storage chamber
C. filter-drier
D. heat exchanger
E. none of these

62. In a normally operating domestic refrigeration system, the evaporator tubes are completely covered with frost.

A. True
B. False

63. In a normally operating capillary tube system, the evaporator is completely filled with liquid refrigerant.

A. True
B. False

64. In a normally operating capillary tube system, when the compressor is not running, the high- and low-side pressures tend to equalize.

A. True
B. False

65. In a normally operating system, approximately half the condenser contains high-pressure liquid.

A. True
B. False

66. A system that exhibits low head pressure and high back pressure probably is suffering from

A. a restriction
B. an overcharge of refrigerant
C. an undercharge of refrigerant
D. low compressor capacity
E. inadequate condenser

67. An undercharged system can be mistaken for

A. a restricted system
B. an overcharged system
C. low compressor capacity
D. inadequate condenser

68. A restriction in the system usually occurs at the

A. condenser outlet
B. capillary tube outlet
C. compressor inlet
D. suction line
E. accumulator

69. Which of the following will exhibit a large drop in temperature from one part of the condenser coil to another part?

A. restricted system
B. undercharged system
C. excessive overload
D. inadequate condenser
E. inadequate compressor

70. If a system is undercharged, the addition of a small amount of refrigerant will result in

A. a sharp rise in head pressure to excessively high
B. a gradual rise in head pressure
C. cooling of the filter-drier
D. frosting of the suction line

71. Frosting of the suction line is probably due to

A. an undercharged system
B. an overcharged system
C. a restricted system
D. low compressor capacity

72. Lubrication by means of an oil pump requires that the oil pressure in the compressor be known. This value is computed by

A. subtracting the oil pump intake pressure from the outlet pressure of the compressor.
B. adding the intake and outlet pressures
C. subtracting the outlet pressure from the intake pressure
D. none of these

73. Which of the following can be used to cool the compressor?

A. air
B. water
C. refrigerant
D. all of these

74. An unloader can be used to

A. evacuate the system
B. limit the capacity of the compressor
C. remove liquid from the condenser
D. all these

75. The thermostatic expansion valve is most useful on direct expansion evaporators.

A. True
B. False

76. The thermostatic expansion valve operates on superheat in the evaporator.

A. True
B. False

77. The temperature difference (TD) in the evaporator is

A. the difference between the temperature of the refrigerant and the substance being cooled.
B. the difference between the temperature of the air flowing over the evaporator and the substance being cooled.
C. the difference between the inlet and outlet temperatures of the refrigerant.
D. none of these

78. Water-cooled systems are more efficient than air-cooled systems of the same size.

A. True
B. False

79. In a normally operating low temperature commercial refrigeration system, the evaporator coils are completely covered with frost.

A. True
B. False

80. In a normally operating system, the evaporator is completely filled with liquid refrigerant.

A. True
B. False

81. In a normally operating expansion valve system, the high and low-side pressures tend to equalize rapidly when the compressor is not running.

A. True
B. False

82. In a normally operating system, approximately half the condenser contains high-pressure liquid.

A. True B. False

83. A system that exhibits low head pressure and high back pressure is probably suffering from

A. a restriction
B. an overcharge of refrigerant
C. an undercharge of refrigerant
D. low compressor capacity
E. inadequate condenser

84. The abnormality of an "undercharged system" can be mistaken for
A. restricted system
B. overcharged system
C. low compressor capacity
D. inadequate condenser

85. A restriction on the system usually occurs on the
A. high side of the system
B. low side of the system

86. Which of the following conditions exhibits a large drop in temperature from the inlet of the condenser coil to the outlet?

A. restricted system
B. undercharged system
C. excessive overload
D. inadequate condenser
E. inadequate compressor

87. If a system is undercharged, the addition of a small amount of refrigerant will result in

A. a sharp rise in head pressure to excessively high
B. a gradual rise in head pressure
C. cooling of the filter-drier
D. frosting of the suction lines

88. Frosting of the suction line is probably due to

A. an undercharged system
B. an overcharged system
C. a restricted system
D. low compressor capacity

Unit 22 - Quiz #2

NAME: _____

1. Explain how a cooling tower is used as a method of heat rejection.

2. Draw a diagram of a water cooled condensor that dumps the water after use. Show the entire system and label the state the refrigerent is in at the points in the system.

3. What is a secondary refrigerent system?

4. What controls the temperature of domestic walk in boxes? Explain how this control is set to maintain a 38 to 41 refer.

5. Name 3 different types of condensors, including domestic.

6. Consider you are a service man called in on a commercial freezer that you are told doesn't work right. Give a detailed account of how you would check the system. Check every aspect of the refrigeration cycle in the unit, step by step.

7. Again you are a service man, only on a domestic refrigerator. Will your procedure change? If so explain changes. The refrigerator has a freezer & refer section & ice cuber in the door.

8. What type of metering device is used in a domestic refrigerator?

9. What are five of the most common problems that you will come across in servicing air cond. & refrigeration equipment?

10. What is a heat exchanger in a refrigeration system, and what purpose does it serve?

AREA - REFRIGERATION SERVICE PROCEDURES

Unit 23 - Commerical Refrigeration and Air Conditioning

I. Instructional Objectives:
To acquaint the student with the differences between residential and commerical equipment. To provide student with working knowledge of commercial refrigeration and air conditioning from both an installation and service standpoint. Deals with walk in freezers and coolers, reach ins, ice cubers, store coolers, commercial, industrial, institutional comfort cooling. Types of temperature control and methods of defrosting are also taught the student. Students will learn walk in equipment sizing.

II. Reference Materials
Environmental Control, part 3
Refrigeration and Air Conditioning, chapter 14
RETA Industrial Refrigeration I & II
Trane Reciprocating Refrigeration, all
Modern Refrigeration 12-15

III. Visual Aids
Carrier GTR, Chapter 1-16
Overheads of sizing charts

IV. Method Performance Conditions
Given walk in freezer and cooler, reach in case, open case, various brands of ice cubers, water coolers, various total building cooling systems, chillers, water tower, swamper, roof top equipment, student will work on installing and servicing all of these in the lab.

V. Outline

1. General discussion on types and uses of commercial equipment.
2. Load calculations
   A. equipment selection of commercial comfort equipment
3. Control devices used in commercial equipment.
4. Selection of proper system to meet the needs of the commercial job (human comfort).
5. Freezer
   A. Construction
   B. Design

6. Sizing a freezer for a given application.
7. Proper component selection
   A. freezer application
   B. cooler application
8. Electrical controls
   A. commercial applications (product)
9. Compressor design
10. Motor controls
11. Capacity control systems
12. Head pressure control systems
13. Multiple systems
14. Defrost systems
15. Heat recovery systems
16. Ice cubers
17. Ice flakers

Sample Reading Assignment

			Answer
September 28	Chapter	Pages	Questions
October 5	12	393-428	1-20
October 12	"	429-462	21-40
October 19	13	463-475	1-15
October 26 (meet in lab)	13	476-487	16-30
November 2	14	489-505	1-15
November 9 mid term exam	14	506-522	16-30
November 16	14	523-539	31-45
November 23	14	540-552	46-60
November 30 (meet in lab)	15	553-578	1-15
December 7	15	579-601	16-30
December 14 final exam			

IV. Student Evaluation Parameters

Student will demonstrate servicing of all units listed in method performance conditions. Student will install and do timed servicing of all types of commercial equipment. Student will perform sizing of sample refrigeration equipment.

VII. Sequence of Instruction

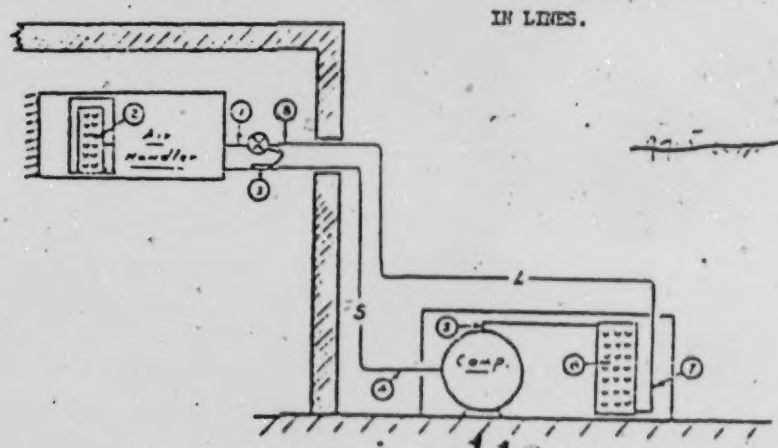
1. Read all reference materials.
2. View visual aids.
3. Discuss commercial equipment while touring operating systems.
4. Do sizing of walk in freezer and cooler.
5. Install different types of commercial equipment.
6. Create service problems and have student solve - timed.
7. Have metering device manufacturer representative give talk on commercial refrigerant controls.
8. Do unit tests.

Unit 23 - Sample Lab

Using a pressure/temperature chart fill in blanks. Refrig 12, assume no pressure drop in lines, use psig. Under refrig, mark it it is H P Vapor, mix of L.P. Vapor and Liq. L.P. vapor, H.P. liq. Is it subcooled or superheated liq. or vapor, if so how many degrees: (to be listed under refrig. also):

1. Leaving TEV
   a. Temp_____
   b. Press 9.2
   c. Refrig._____
2. Center of Evap Coil
   a. Temp_____
   b. Press_____
   c. Refrig_____
3. Outlet of evap.
   a. Temp 14.7
   b. Press_____
   c. Refrig_____
4. Inlet at Comp.
   a. Temp 55°
   b. Press_____
   c. Refrig_____
5. Leaving Compressor
   a. Temp 150°
   b. Press 136.7
   c. Refrig_____
6. Center of Condenser
   a. Temp_____
   b. Press 136.7
   c. Refrig_____
7. Leaving Condenser
   a. Temp 95°
   b. Press_____
   c. Refrig_____
8. Inlet to T.E.V.
   a. Temp 85°
   b. Press_____
   c. Refrig_____

REFRIGERANT ~~22~~ / 12
ASSUME NO PRESSURE DROP
IN LINES.



Unit 23 - Sample Lab

Objective: Review of theory, part and service proceedures.

Introduction to Commercial Refrigeration.

Sources, texts: (Environmental Control, Sec 24,25)
lectures, laboratory

1. Common industry practice is to refer to a condensing unit's capacity as two Horse power or two_____.

2. If the air intake temperature on an Air Cooled Condenser decreases, describe the effects on head pressure.

_____

_____

3. Which of the three methods of heat transfer is most often used in Commercial Refrigeration?_____

4. Describe the differences between a pressure and compound gage.

_____

_____

5. What is the primary difference between a self-contained and a remote condensing unit?

_____

_____

6. Three common methods of refrigerant leak detection are:

_____

_____

7. True/False Doctors are confident that there are no long term effects from breathing refrig. vapors. _____

8. What other function does a dryer often serve?

_____

_____

9. From a service point of view, the primary difference between a hermetic and a semi-hermetic is:

_____

_____

10. Advantages of an open Compressor are:

_____

_____

11. Disadvantages of an open Compressor are:

_____

_____

12. The two primary types of Condensers are:

_____

13. The refrigerant metering device most usually used in Commercial systems is the:

_____

14. Name at least ten (10) Commercial uses of refrigeration.

_____

_____

_____

15. The four (4) temperature ranges are named:

_____

_____

16. Which temperature range is a Floust Box?_____

17. Which temperature range is a Meat Storage Frz.?_____

18. Which temperature range is an Air Conditioner?_____

19. Of the three above units, on which is defrost more complicated.

_____

20. Why do chest display case cool more efficiently than upright cases?

_____

_____

Unit 23 - Sample Lab

Objective: To familiarize student with some types of basic commercial refrigeration equipment and service proceedures.

1. Three problems that can occur if air is introduced into a system are:

_____

_____

_____

2. Two ways of evacuating air are:

_____

_____

3. The most common place in the system to locate a dryer is:

_____

4. When there is a moisture problem in a Low Temp. (L.T.) system, where do many servicemen put an additional dryer?

_____

5. A long term source of trouble due to air is:

_____

_____

6. How would you determine if a T.E.V. is froze up?

_____

_____

7. Describe a common proceedure to evaluate a Comp. effeciency using gages.

_____

_____

_____

8. If a condensor fan motor is defective, what device can stop the compression and prevent blowing the charge?

_____

9. Three methods of compression cooling are:

_____

_____

10. Describe two (2) ways to lower capacity on a condensing unit compressor.

_____

_____

11. Describe several methods of cleaning an Air Cooled Condenser.

_____

_____

_____

12. Where ever possible three phase (Ø) units are used, possible reasons are:

_____

_____

_____

13. Briefly explain the differences between an E.P.R. and a C.P.R.

_____

_____

14. What refrig. would you expect in an AC unit with a 400# PRV?

15. What refrig would you expect in a Low Temp. with a 400# PRV?

16. What refrig would you expect in a Beer Cooler with a 253# PRV?

Unit 23 - Sample Lab

Describe in detail what you would do in changing a burn out semi-hermetic compressor on a remoted condensing unit.

Unit 23 - Sample Lab

1. Write five questions and answers to be used in a final exam.
2. List five things that you do not understand (to be taken from class, homework, quiz, or lab).
3. Write a paragraph or two about the progress of the class and your individual results. Also suggestions for improvement.

Unit 23 - Sample Lab

TEV operation and Head Pressure Control

TEV - Source - TEV pass-out, lecture, texts.

1. Read fig. I; If the pressure at the TEV outlet is 37#, what is the pressure at the outlet?

_____

2. Factory Superheat setting usually is

_____

3. How would you check a TEV if it is not passing gas?

_____

_____

_____

4. Describe an external equalizer. Why is it used?

_____

_____

5,6. How would you adjust and measure an externally adjustable TEV? (use an example)

Head Pressure Controls Sources: Texts, pass-out, lecture

7. How should a Kramer "Winterstat" and other valves be heated and sweated into the line?

_____

_____

8,9. Why must head Pressure control be used with a remote condenser in the Chicago area?

_____

_____

10,11,12. Describe 3 methods of Controling Head pressure on a Spring,Summer, Fall A.C. system with a O.S. Air Cooled Cond.

(1) _____

(2) _____

(3) _____

13. Describe the principle used in Head Pressure Control valves.

14. Draw and lable a piping diagram of a Sporland OR05/ORD 20 H.P. control valve system.

15. Draw and lable a Head Pressure Control system using a OR1-6 (Sporland) 100/225.

16. What is the purpose of having an oversized receiver with a Head Press. Control system?

17. What does OR1 stand for?

18. What does OROstand for?

19. Why do you add extra refrig. (after filling sight glass) to above units when charging in the summer?

Unit 23 - Sample Lab

Purpose To learn the principles and operation of the Defrost of Commercial Refrigeration

Sources Lectures, text and pass-out

1. Why is defrost usually not a problem on a A.C. unit running under normal conditions?

_____

_____

2. On the same unit, someone lowers the thermostat to 50°, and the O.S. temperature drops to 70°, could the coil frost up?

3,4. Describe 2 methods of defrosting control of the above A.C..

_____

_____

5. Describe a "defrost cycle" defrost of a Salad Reach-In Box.

_____

_____

6. Describe a "Time-Time" defrost of a Lunch Mt. Cooler.

_____

_____

7. Describe a "Time-Pressure" defrost.

_____

_____

8. Describe a "Time-Temperature" defrost.

_____

_____

9,10,11. Describe a "Hot Gas" defrost.

_____

_____

_____

12. Why are elec. heaters used on a freezer unit rather than an off cycle?

_____

_____

13. Describe a "Hot Gas Bypass" to defrost an A.C. unit.

_____

_____

14. Describe a time clock "Fail Safe".

_____

_____

15. Please write down any comment or questions you have on defrost.

_____

_____

_____

16. Why are the pilot circuit Contacts on a Time Clock smaller than the heater contacts?

_____

_____

Unit 23 - Quiz #1

Name_____

1. With an open type compressor on a low temperature unit operating with the low side in a vacuum, a leaking shaft seal could cause what problem worse than a loss of refrigerant?

2. Which is generally harder on a compressor, continous operation or cycling?

3. How does an increase in discharge pressure affect compressor capacity?

4. What affect does an increased discharge pressure have on motor load?

5. How can too low of a suction gas superheat be harmful to the compressor?

6. Why should excessive suction gas temperatures be avoided on hermetic compressor application?

7. For best overall performance, the suction gas temperature should be controlled at what minimum superheat?

8. What affect does a high discharge gas temperature have on the compressor oil?

9. What happens to compressor capacity as suction pressure is increased?

10. What happens to a compressor volumetric efficiency as the suction pressure goes down and as ratio of compression increases?

11. Does the "BTU/WATT" go up or down as the discharge pressure goes up?

12. When selecting an air-cooled condensing unit, what needs to be known about the ambient air?

13. When selecting a water-cooled unit to be used with a cooling tower, what needs to be known about the ambient air?

14. In servicing a condensing unit, should oxygen be used to blow out refrigerant lines?

15. In charging refrigerant into a condensing unit, should it be charged as a liquid or vapor?

16. On a water chiller application, where the gallons of water chilled are known as well as temperature drop, how is the unit capacity determined?

17. What must be known about the air flowing through the air conditioning coil, to determine the units capacity?

18. Should the system compressor be used to evacuate a system?

19. When evacuating a system, what is the recommended vacuum to be drawn on the system?

20. When replacing valves in compressor, the unit must first be pumped down to what pressure?

21. If upon removing the valve plate on an open type compressor, copper plating and corrosion is evident, what problem is indicated?

22. If corrosion or copper plating is not too severe, what service procedure would normally suffice?

23. What service procedure on an open type unit is called for if corrosion appears to be severe?

24. When installing new head gaskets, what should be done to them before placing them in position?

25. What could happen if a new head gasket is thinner than the original one?

26. What precaution must be observed in regard to the seal nose or ring when replacing a shaft seal?

27. When replacing a compressor seal, what should be done to the new seal gaskets before they are put in place?

28. What problem would worn connecting rods usually cause in a compressor?

29. In an emergency, how can a loose ringless piston be made to operate satisfactorily?

30. In an open type compressor application when good shop facilities are available, what can be done to correct badly worn or scored cylinder walls?

31. After repairing an open type compressor and testing for leaks with dry nitrogen, what precaution must be observed?

32. What are the three types of refrigeration condensers?

33. The heat rejected at the condenser must equal the sum of what two heat sources in the refrigeration system?

34. What three temperature stages does the refrigerant go through as it passes through the condenser?

35. What is subcooling, and why is it done?

36. What effect will non-condensable gases have in the refrigerating system?

37. Name some sources of non-condensable gases in a refrigeration system.

38. How is an air-cooled system checked for non-condensable gases?

39. Does an excessive discharge pressure while the compressor is running always indicate non-condensable gases in the system?

40. What are the important points to remember in purging a system?

41. Why do condensers with closer fin spacing require attention more often than those with wide fin spacing?

42. How may discharge line pulsations and noise be eliminated?

43. What is "bleed off" in an evaporative condenser?

44. What methods are used to prevent winter freeze-up on evaporative condensers?

45. Why are the majority of the medium size package systems equipped with water-cooled condensers?

46. What problems are usually encountered when using sea or river water as a cooling agent?

47. What precautions must be taken with regard to natural elements on an outside installation of a cooling tower or evaporative condenser?

48. What effect will wind blowing into the fan have on fan performance?

49. What maintenance should be given to water tower and evaporative condenser float valves?

50. What type of maintenance care is required on cooling towers and evaporative condensers in order to keep systems clean and head pressures down?

51. What monthly service should be performed to insure that the water flow will be unrestricted?

52. What is the normal bleed-off rate for water saving devices?

53. In checking the bleed rate on a cooling tower for a 10 ton refrigeration system, how long should be required to fill a quart container?

54. In what ways may sodium hexametaphosphate be fed into the cooling water system?

55. If inspection of the system indicates that condenser surfaces are getting scaled, what operation should be performed?

56. If scale remover must be used more often than 2 or 3 times a year, what corrective steps should be taken?

57. Where do the dirt and other loose deposits which collect in the tower or evaporative condenser water system come from?

58. How often should the cooling tower or evaporative condenser be cleaned?

59. What factors contribute mainly to scale formation?

60. In what ways may CO_2 be released from the cooling water, thus contributing to scale formation?

61. How does a flue gas injector help to control the formation of lime scale?

62. What is the maximum recommended bleed-off for most conditions? What concentration is maintained?

63. What may result if the concentration of sodium hexametaphosphate in the recirculating water system is raised to more than 20 ppm?

64. Even though water treatment is used, what must be done periodically to prevent a heavy build-up of sclae deposits?

65. Under what general water conditions would you expect to find corrosion to be a problem?

66. Why does the recirculating water through a cooling tower become acid when the makeup has low alkalinity?

67. In what areas are algae and other organic growths likely to be a problem?

68. What chemicals may be used to control organic growths?

69. If the algai growth is more of a problem than scale formation, what may be necessary?

70. Before attempting to solve any cooling tower or evaporative condenser water problem, what action should be taken?

71. In a 2 ton commercial freezer designed to operate at -5°F, what should be the normal for air temperature entering the coil?

72. In a 2 ton commercial freezer designed to operate at -5°F, what should be the normal for air temperature leaving the coil?

73. In a 2 ton commercial freezer designed to operate at -5°F, what should be the normal for refrigerant temperature?

74. In a 2 ton commercial freezer designed to operate at -5°F, what should be the normal for cfm of air?

75. What are the approximate "rules-of'thumb" for cfm of air per ton for air conditioning?

76. What are the approximate "rules-of-thumb" for cfm of air per ton for 35° commercial temp. refrigerator.

77. What are the approximate "rules-of-thumb" for cfm of air per ton for below 0° freezer?

78. What will be the result if the coil is operated at a greater than normal "TD"?

79. How does increasing the "TD" affect humidity in the refrigerated space?

80. If the RH of the refrigerated space is too high, what can be done to lower it?

81. What two things should be considered in the placement of a coil unit?

82. What effect will refrigerant pressure drop have on the coil?

83. Explain the normal operation of a TEV when the compressor cycles off.

84. How does the TEV react when the compressor starts?

85. What affect does increasing the spring tension on the TEV have on the superheat?

86. How does a TEV maintain the operating superheat when too much refrigerant enters the evaporator.

87. What actually determines the superheat of the TEV.

88. Should an external equalizer be connected up stream or down stream of a evaporator pressure regulator?

89. When soldering a TEV to connecting lines, what extra precaution should be observed?

90. When used to prevent formation of flash gas, where should the suction liquid heat exchanger be located?

91. Is it good practice to locate a TEV remote feeler bulb on a suction header?

92. What is the possible consequence of locating the TEV remote bulb on suction line trap where it would feel trapped liquid?

93. When fastening a TEV bulb to a suction line, may it be taped on in place of using a clamp?

94. On a application with no appreciable pressure drop in the suction line, what is the operating superheat of the valve if the suction pressure reads 37# and the temperature at evaporator outlet at bulb location is 51° in a system using R- 2?

95. What temperature range of superheat is considered normal for air conditioning applications?

96. In order to obtain maximum coil capacity, what is the usual superheat setting for low temperature applications?

97. How will an excessively high superheat affect the system capacity?

98. What problem may be encountered on an application with too small of a superheat?

99. What does a lower then normal compressor power consumption and excessive compressor running time tell us about the refrigerant charge?

100. If the remote bulb of a TEV loses its charge, how will it cause the valve to react?

101. What affect on valve superheat will a leaking TEV orifice cause?

102. Increasing spring tension on a TEV will change its superheat in which manner?

Unit 23 - Quiz #2

DIRECTIONS: Select the correct answer(s) and circle the letter in front.

1. A reed valve normally has:
   a. 4 springs
   b. 2 springs
   c. No springs
   d. The number of springs is determined by the valve size.

2. A mechanical shaft seal is necessary in a:
   a. Semi-hermetic compressor
   b. Hermetic reciprocating compressor
   c. Hermetic rotary compressor
   d. Open type compressor

3. One of the following is <u>not</u> a "Mechanical Design Factor" affecting compressor capacity:
   a. Piston displacement
   b. Compressor speed
   c. Clearance space
   d. Suction and discharge valve design

4. Which one of the following would <u>not</u> be useful in determining compressor displacement?
   a. Length of piston
   b. Diameter of piston
   c. Revolutions per minute
   d. Number of cylinders
   e. Piston displacement

5. Clearance volume:
   a. Has no effect on compressor capacity
   b. Has effect on compressor capacity
   c. Varies depending upon compressor speed
   d. Is the same on all compressors.

6. Compression ratio in a refrigeration compressor:
   a. Is the ratio of the absolute suction pressure to the absolute discharge pressure.
   b. Is increasing due to advances in gasoline octane
   c. Is the ratio of the absolute discharge pressure to the absolute suction pressure
   d. Is constant with each compressor

7. Liquid slugging is:
   a. The pounding of liquid refrigerant in the suction line at a point of restriction
   b. A presence of liquid in the condenser causing excessive noise
   c. Liquid in compressor clearance space
   d. Excessive liquid refrigerant in the receiver

8. A compressor capacity reduction device always:
   a. Reduces compressor capacity by reducing compressor horsepower proportionately.
   b. Reduces compressor capacity by reducing compressor speed
   c. Reduces compressor capacity by bypassing hot gas
   d. Reduces compressor capacity as the refrigeration load dictates

9. A moisture indicator is usually found in the suction line close to the compressor. . . . . T F

10. A suction accumulator is nothing more than a trap. . . T F

11. An oil separator will keep all oil from circulating through the refrigerant system. . . . . T F

12. The selection of the size and location of a muffler is a simple field problem. . . . . T F

13. An electrical crankcase heater is usually electrically wired so that it is "on" when the compressor is "off" . T F

14. A solenoid valve may be used to control the flow of a gas or a liquid. . . . . T F

15. The oil safety switch protects the system against low oil pressure. . . . . T F

DIRECTIONS: Circle the letter in front of the correct answer(s)

16. The material within a strainer drier is known as a
    (a) designate
    (b) filling
    (c) desiccant
    (d) desecrate

17. "Foaming" in a compressor crankcase can
    (a) mean thickening of the oil.
    (b) create liquid slugs.
    (c) indicate too much oil in the refrigerant.
    (d) indicate that the crankcase heater is not going "off"

18. A sight glass in a full liquid line will be
    (a) full of bubbles.
    (b) cloudy.
    (c) light green.
    (d) clear.

19. A receiver
    (a) is part of the condenser.
    (B) stores liquid refrigerant.
    (c) is an essential part of the system.
    (d) stores refrigerant gas.

20. An evaporator pressure regulator is designed to maintain a constant pressure or temperature in the evaporator.
    (a) regardless of how high the compressor suction pressure may go.
    (b) regardless of how high the condenser pressure may go.
    (c) regardless of how low the compressor suction may go.
    (d) regardless of how low the condenser pressure may go.

21. The oil separator is always inserted in the system
    (a) to prevent oil logging.
    (b) in a cool spot.
    (c) where it can be easily serviced.
    (d) in the discharge line.

22. A suction accumulator always has
    (a) an oil return line.
    (b) an inlet and outlet.
    (c) a coil of liquid line around it.
    (d) complex control system.

23. A refrigeration accessory is an article or device that
    (a) adds to the convenience of a system.
    (b) comes in many forms.
    (c) is not essential in a refrigeration system.
    (d) adds to the effectiveness of a system.

24. Condensing mediums must
    (a) be a liquid.
    (b) be a gas.
    (c) be non-corrosive.
    (d) be in the right temperature range.

25. Natural draft condensers are most frequently found
    (a) in residential cooling.
    (b) in a large industrial plants.
    (c) in household refrigerators.
    (d) in room air conditioners.

26. The horizontal shell and tube condenser is more efficient than the vertical shell and tube condenser because
    (a) it is mounted in a horizontal position.
    (b) it is easier to clean.
    (c) the water passes through it more than once.
    (d) it takes advantage of more air cooling.

27. The capacity of an evaporative condenser depends on
    (a) fan horsepower.
    (b) the amount of heat leaving air is capable of absorbing.
    (c) entering air wet bulb.
    (d) the temperature of the entering air.

28. A cooling tower
    (a) is an accessory to a condenser.
    (b) is always used where water is scarce.
    (c) must be in a location where the prevailing wind blows.
    (d) a labor saving device.

29. A receiver is
    (a) a necessary component of all refrigerant systems.
    (b) a complicated piece of equipment
    (c) usually found on the low side of the system.
    (d) a storage tank.

30. A condenser is
    (a) always mounted above the compressor.
    (b) a good cost saving accessory to a refrigeration system.
    (c) the exit door for refrigerant heat in a refrigeration system.
    (d) a water saving device.

DIRECTIONS: Circle T for True or F for False.

31. T F A unit with a 1 HP motor is often referred to as a One Ton unit.

32. T F There is a definite relationship between pressure and temperature of the refrigerant boiling point.

33. T F As back pressure decreased, compressor capacity decreases.

34. T F The greater the T D across the coil, the greater the Evap capacity.

35. T F A popular form of refrigerant metering device is the Evap. Press. Reg.

36. T F An evap. fan not running increases suction pressure.

37. T F A dirty condenser causes hi head pressure.

38. T F A compressor unloader is often used on a system with a varying load.

39. T F Sil-flos requires more heat than 95/5.

40. T F Sil-flos requires flux for a copper to copper joint.

41. T F If nitrogen is not available oxygen can be used safely to pressurize a system.

42. When joining steel to copper, what type of joint should be used on refrigerant discharge lines?
    (a) 95/5
    (b) 50/50
    (c) Sil-flos 15
    (d) Silver solder 50%

Unit 23 - Quiz #3

1. The cooling component of a refrigeration system is called:
   a. a canteen
   b. an ice box
   c. an evaporator
   d. a conceiver

2. A refrigerant gives up heat when it:
   a. condenses
   b. evaporates
   c. regurgitates
   d. vaporizes

3. For practical purposes, the high side of a refrigeration system includes:
   a. the metering device
   b. the compressor
   c. the evaporator
   d. the operating engineer

4. For practical purposes, the low side of the system includes:
   a. the metering device
   b. the condenser
   c. the compressor
   d. the receiver

5. The thermostatic expansion valve is designed to maintain:
   a. constant flow
   b. constant temperature
   c. constant superheat
   d. constant pressure

6. A receiver is used:
   a. to condense refrigerant
   b. to cool hot gas
   c. to separate oil
   d. to store refrigerant

7. A capillary is located
   a. in the liquid line feeding the coil
   b. at the leaving side of the coil
   c. in the hot gas line
   d. at the condenser inlet

8. The boiling temperature of water in an open vessel at 14,000 ft. is:
   a. 212^{o}
   b. 970^{o}
   c. 144^{o}
   d. 186^{o}

9. The automatic expansion valve maintains a constant pressure at:
   a. the condenser inlet
   b. the evaporator inlet
   c. the liquid line
   d. the condenser outlet

10. If a drum of dichlorodifluoromethane; partially filled with liquid refrigerant, is stored in a 32° room the pressure in the drum would be:
    a. 10 lbs.
    b. 124 lbs.
    c. 16 lbs.
    d. 30 lbs.

DIRECTIONS: Fill in the blanks with the proper words.

11. Name the major components of a closed cycle refrigeration system:

    _____ _____

    _____ _____

12. A refrigerant is a fluid that picks up heat by evaporating at a _____ temperature and pressure and condensing at a _____ temperature and pressure.

13. The cooling coil of a refrigeration system is commonly called the

    _____

14. Refrigerant enters the compressor at a _____ temperature and pressure and is _____ to a _____ temperature and pressure.

15. The _____ controls the flow of refrigerant to the evaporator.

16. For practical purposes the low side of a refrigerant system includes:

    _____, _____, _____ and _____.

17. For practical purposes the high side of a refrigeration system includes:

    _____, _____, _____ and _____.

18. The types of metering devices are: _____, _____, _____, _____, _____ and _____.

19. The boiling point of dichlorodifluoromethane (Freon 12, Genetron 12) at 0 psi gauge is _____.

20. The division points between the high and low sides of the system are _____ and _____.

21. A reed valve normally has:
    a. 4 springs
    b. 2 springs
    c. no springs
    d. the number of springs is determined by the valve size

22. A mechanical shaft seal is necessary in a:
    a. semi-hermetic compressor
    b. hermetic reciprocating compressor
    c. hermetic rotary compressor
    d. open type compressor

23. One of the following is not a "Mechanical Design Factor" affecting compressor capacity:
    a. piston displacement
    b. compressor speed
    c. clearance space
    d. suction and discharge valve design

24. Which one of the following would not be useful in determining compressor displacement?
    a. length of piston
    b. diameter of piston
    c. revolutions per minute
    d. number of cylinders
    e. piston displacement

25. During the re-expansion portion of the refrigerant compressor cycle:
    a. the suction valve is open
    b. the suction valve is closed
    c. the discharge valve is open
    d. the discharge valve is closed

26. Clearance volume:
    a. has no effect on compressor capacity
    b. has effect on compressor capacity
    c. varies depending upon compressor speed
    d. is the same on all compressors

27. Compression ratio in a refrigeration compressor:
    a. is the ratio of the absolute suction pressure to the absolute discharge pressure
    b. is increasing due to advances in gasoline octane
    c. is the ratio of the absolute discharge pressure to the absolute suction pressure
    d. is constant with each compressor

28. Liquid slugging is:
    a. the pounding of liquid refrigerant in the suction line at a point of restriction
    b. a presence of liquid in the condenser causing excessive noise
    c. liquid in compressor clearance space
    d. excessive liquid refrigerant in the receiver

29. A compressor capacity reduction device always:
    a. reduces compressor capacity by reducing compressor horsepower proportionately
    b. reduces compressor capacity by reducing compressor speed
    c. reduces compressor capacity by bypassing hot gas
    d. reduces compressor capacity as the refrigeration load dictates

30. All refrigeration compressor valves are:
    a. opened and closed by external springs
    b. opened and closed by inherent spring tension
    c. opened and closed by pressure difference
    d. opened and closed by a camshaft

31. The function of a compressor is to take refrigerant vapor at a _____ temperature and pressure and change it to a _____ pressure and temperature.

32. In a full hermetic compressor both the _____ and the _____ are totally enclosed.

33. Three common types of compressor seals are the _____, _____ and _____

34. Compressors may be lubricated by either, or both, the _____ system or _____ system.

35. Compressor displacement is piston displacement times _____

36. Piston displacement= $\frac{\pi D^2 L\ (?)}{4}$

37. During the re-expansion portion of the refrigeration cycle the discharge valve is _____ and the suction valve is _____

38. Increasing the clearance volume will _____ compressor capacity.

39. Compression ratio is the ratio of the absolute _____ pressure to the absolute _____ pressure.

40. Three common methods of controlling compressor capacity are: _____, _____, and _____

41. The main purpose of a condenser is to
    a. store liquid refrigerant
    b. remove heat from the refrigerant
    c. remove water from the refrigerant system
    d. add heat to the refrigerant

42. Condensing mediums must
    a. be a liquid
    b. be a gas
    c. be non-corrosive
    d. be in the right temperature range

43. Natural draft condensers are most frequently found
    a. in residential cooling
    b. in large industrial plants
    c. in household refrigerators
    d. in room air conditioners

44. The horizontal shell and tube condenser is more efficient that the vertical shell and tube condenser because
    a. it is mounted in a horizontal position
    b. it is easier to clean
    c. the water passes through it more than once
    d. it takes advantage of more air cooling

45. Gas (R-12) enters the condenser at 116.9 psig, 100F. It leaves the condenser at 80°F. Its pressure will be
    a. 76.9 psig.
    b. 84.1 psig.
    c. 91.7 psig.
    d. 116.9 psig.

46. 10 lbs. of refrigerant pass through the condenser and give up 20 Btu's of heat per lb. Ten lbs. of water pass through at the same time and the entering temperature is 80F. The leaving temperature is
    a. 80F
    b. 95F
    c. 100F
    d. 110F

47. The capacity of an evaporative condenser depends on
    a. fan horsepower
    b. the amount of heat leaving air is capable of absorbing
    c. entering air wet bulb
    d. the temperature of the entering air

48. A cooling tower
    a. is an accessory to a condenser
    b. is always used where water is scarce
    c. must be in a location where the prevailing wind blows
    d. a labor saving device

49. A receiver is
    a. a necessary component of all refrigerant systems
    b. a complicated piece of equipment
    c. usually found on the low side of the system
    d. a storage tank

50. A condenser is
    a. always mounted above the compressor
    b. a good cost saving accessory to a refrigeration system
    c. the exit door for refrigerant heat in a refrigeration system
    d. a water saving device

51. A condenser is a device for removing _____ from the refrigeration system.

52. _____ and _____ are normally used for condensing refrigerant mediums.

53. There are three basic types of condensers, the _____ cooled, the _____ cooled and the _____ cooled.

54. The natural draft air-cooled condenser would normally be too _____ for practical application to large systems.

55. The forced air condenser uses both _____ and _____ type fans.

56. The horizontal shell and tube condenser is _____ to clean.

57. The water circulates _____ the tube in a shell and coil water-cooled condenser.

58. In all condenser operation the heat _____ by the condensing medium must equal the heat _____ by the refrigerant.

59. In an evaporative condenser, heat is picked up from the refrigerant by use of the principle: _____ of water requires heat.

60. Most heat removed from the refrigerant in a condenser is of the _____ variety.

61. The evaporator is a device to
    a. store liquid refrigerant
    b. absorb heat into the refrigeration system
    c. remove heat from the refrigeration system
    d. keep the compressor busy

62. The temperature of the medium being cooled must be
    a. below evaporator temperature
    b. equal to evaporator temperature
    c. above evaporator temperature
    d. below freezing

63. The two basic types of evaporators are
    a. finned and plate
    b. prime surface and finned
    c. direct expansion feed and plate
    d. flooded and direct expansion feed

64. The heat picked up in the evaporator must equal
    a. the heat of compression
    b. the heat given up by the condenser
    c. the heat lost by the medium being cooled
    d. the heat gained by the condenser

65. Liquid Refrigerant 22 enters an evaporator @ 50.2 psig 20F and leaves @ 38F. Its pressure as it leaves will be
    a. 36.9 psig.
    b. 43.3 psig.
    c. 50.2 psig
    d. 66.1 psig

66. 10 lbs. of refrigerant pass through an evaporator and pick up 10 Btu's of heat per lb. Ten lbs. of water pass through the evaporator at the same time and the entering temperature is 60F. The leaving temperature is
    a. 45F
    b. 50F
    c. 55F
    d. 70F

67. The selection of the proper evaporator depends mainly on
    a. price
    b. size
    c. application
    d. color

68. Secondary refrigerants are usually
    a. Prestone
    b. Alcohol
    c. water or brine
    d. expensive

69. Flooded feeds are different from direct expansion feeds in that they
    a. are not as efficient
    b. use bigger evaporators
    c. allow for regurgitation of liquid refrigerant
    d. allow for recirculation of liquid refrigerant

70. Prime surface vaporators operating below 32F must frequently be
    a. cleared
    b. purged
    c. painted
    d. defrosted

71. An evaporator is a device for absorbing _____ into the refrigeration system.

72. There are two basic types of evaporators, the _____ type and the _____ type.

73. The heat _____ by the refrigerant in an evaporator must equal the heat _____ by the medium being cooled.

74. In an evaporator, heat is picked up by the refrigerant by the use of the principle _____ of refrigerant requires heat.

75. In a direct expansion chiller the refrigerant is _____ the tubes.

76. A flooded feed provides for _____ of the liquid refrigerant.

77. The proper selection of an evaporator depends on its _____

78. When air is cooled, the temperature at which moisture will start to condense is known as the _____ temperature.

79. _____ or _____ are most frequently used as secondary refrigerants.

80. The evaporator temperature must always be _____ than the temperature of the medium being cooled.

81. The metering device is designed to
a. keep the evaporator as cold as possible
b. to control evaporator superheat
c. control the flow of refrigerant
d. to keep a constant evaporator pressure

82. The hi-side float is controlled by
a. the rate of refrigerant evaporation
b. the rate of refrigerant condensation
c. the evaporator temperature
d. the evaporator pressure

83. The lo-side float is controlled by
a. the rate of refrigerant condensation
b. the rate of refrigerant evaporation
c. the evaporator temperature
d. the evaporator pressure

84. The automatic expansion valve is controlled
a. by evaporator temperature
b. by evaporator coil superheat
c. by the rate of refrigerant condensation
d. by evaporator pressure

85. The thermostatic expansion valve has three operating pressures
a. evaporator pressure, spring pressure, suction pressure
b. evaporator pressure, bulb pressure, condensing pressure
c. evaporator pressure, spring pressure, political pressure
d. evaporator pressure, spring pressure, bulb pressure

86. The thermostatic expansion valve is controlled by
a. coil temperature
b. the difference in gas temperature and the temperature corresponding to the gas temperature
c. the difference in gas pressure and the pressure corresponding to the gas temperature
d. coil pressure

87. When the pressure difference across a capillary tube is increased
a. the flow of refrigerant increases
b. the flow of refrigerant decreases
c. it gets noisy
d. there is no change in flow rate

88. The touching surfaces between a thermostatic expansion valve bulb and the suction line
a. must be clean and bright
b. must be clean and tight
c. must be downstream of the equalizing line
d. must be above the coil

89. Flash gas is
    a. useful in cooling the product
    b. necessary in metering devices
    c. not necessary
    d. greater in automatic devices

90. The "heat of compression" is
    a. carried away in the evaporator
    b. sometimes wasted
    c. less on water-cooled compressors
    d. carried away in the cooling medium leaving the condenser

91. A metering device is designed to control the rate of _____ of the refrigerant to the evaporator.

92. There are six major metering devices. They are the _____, _____, _____, _____, _____, and _____

93. The _____ expansion valve is controlled by humans.

94. The _____ float is not used with a receiver.

95. The automatic expansion valve is controlled by evaporator _____

96. The thermostatic expansion valve is controlled by the evaporator _____

97. Superheat is the difference between the actual gas temperature and temperature corresponding to the _____

98. The control point in a thermostatic expansion valve bellows and capillary assembly is where the liquid _____

99. The contacting surface between the thermostatic valve bulb and suction line must be _____

100. When high pressure drop is present in an evaporator, an _____ equalized thermostatic expansion valve is used.

Refrigeration Load Estimate Form (For Rooms Below 32°F)

Customer: _____ Address: _____ Date: _____ Est. By: _____

DESIGN INFORMATION

Application _____

Outside ambient temperature _____ °F

Room temperature _____ °F

Temperature difference (TD) _____ °F

Overall Wall Thickness _____ in.

Product Load _____

Room Dimensions Outside

Length (L) _____ ft

Width (W) _____ ft

Height (H) _____ ft

(If not known, use insulation thickness plus 2 in.)

Insulation

Type _____

Thickness _____ in.

Miscellaneous Loads

Number of people _____ Electrical watts _____

Other _____

SOLUTION

Outside Room Surface Area A

(L) ___ X (W) ___ = _____

(L) ___ X (H) ___ = _____

(W) ___ X (H) ___ = _____

Area A = 2 X _____ = ____ sq. ft.

Inside Room Volume V

(V) = L ft X W ft X H ft = _____

(V) = _____ cu. ft.

Note: For L, W, and H (ft) use outside dimensions less 2 times overall wall thickness.

I. WALL LOAD

(a) Method above: Area A ..... _____ sq. ft.

(b) (Table 23-5) Wall heat gain factor ..... _____ BTU/sq. ft./24 hr

(c) Load: (a) X (b) ..... _____ BTU/24 hr

(d) Total load: item (c) ..... _____ BTU/24 hr

II. AIR CHANGE LOAD

(a) Method above: Volume V ..... _____ cu. ft.

(b) (Table 23-6) Average air changes ..... _____ per 24 hr

(c) (Table 23-8) Heat removal ..... _____ BTU/cu. ft.

(d) Load: (a) X (b) X (c) ..... _____ BTU/24 hr

(e) Total load: item (c) ..... _____ BTU/24 hr

III. PRODUCT LOAD

1. Temperature reduction load before freezing

(a) Weight of product ..... _____ lb

(b) Temperature reduction to freezing ..... _____ °F

(c) (Table 23-9) Specific heat above freezing . _____ BTU/lb/°F

(d) Load: (a) X (b) X (c) ..... _____ BTU/24 hr

2. Latent heat of fusion load

(a) Weight of product ..... _____ (gals.)

(b) Latent heat of fusion ..... _____ (BTU/gals.)

(c) Load ((a) X (b)) ..... _____ BTU/24 hrs

3. Temperature reduction load below freezing

(a) Weight of product ..... _____ lbs

(b) Temperature reduction below freezing .... _____ °F

(c) Specific heat below freezing ..... _____

(d) Load ((a) X (b) X (c)) ..... _____ BTU/24 hrs

IV. MISCELLANEOUS LOADS

(a) Heat equivalent per person _____ BTU/hr

(b) Number of people _____ X (a) _____ X 24 = _____ BTU/24 hrs

(c) Electrical watts _____ X 82 = _____ BTU/24 hrs

(d) Other _____ BTU/24 hrs

V. TOTAL REFRIGERATION LOAD (I + II + III + IV) ..... _____ BTU/24 hrs

VI. SAFETY FACTOR (10% of total refrigeration load) ..... _____ BTU/24 hrs

VII. TOTAL REFRIGERATION LOAD WITH SAFETY FACTOR (V + VI) ..... _____ BTU/24 hrs

VIII. REQUIRED HOURLY CAPACITY = VII _____ X 1/18 hrs ..... _____ BTU/24 hrs

Based on a standard form of the Dunham-Bush Company.

Unit 23 - Quiz #4 NAME _____

1. Ammonia, though an excellent low cost refrigerant, is frequently outlawed for air conditioning use. Which of the following properties is the most responsible for this ruling.

ODOR or FLAMMABILITY

2. TRUE or FALSE Water is rarely a problem in NH_3 systems because the refrigerant will absorb so little of it.

3. Which thermodynamic property requires that CH Cl F_2 equipment be stronger than C Cl_2F_2 equipment used for a similar purpose.

4. The specific volume of NH_3 is about 6-½ times that of CH Cl F_2 but the evaporator equipment for similar applications with the two refrigerants is about the same size. What thermodynamic property makes this possible?

5. Though the halogenated Hydrocarbons are not normally toxic there is one condition that will convert them to toxic gases. What is the condition?

6. In very low temperature work you would expect oils to have _____ viscosity.

(LOW, HIGH)

7. Sludge in the system can usually be traced to moisture in the refrigerant or _____in the oil.

8. A case of pitted valve seats occurs in a dry system. This would indicate the presence of _____in the oil.

9. When copper plating occurs on bearing surfaces, we know that at some place in the system the oil _____is too high.

10. Moisture in refrigerant oil will always create havoc with the refrigerant system. What four items will it most likely produce?

11. Wax would normally expect to leave the oil in a system at the point of _____system temperature.

(HIGHEST, LOWEST)

12. What are two important functions performed by a strainer-drier in a refrigeration system?

(1)

(2)

13. Oil separators are usually installed in which of the following? Select one answer. (a) Suction line

(b) Hot gas line

(c) Liquid line

(d) Equalizer line

NAME _____

14. TRUE or FALSE The function of an oil separator is to:
(a) Prevent oil from leaving the compressor. (a)_____
(b) Reduce oil in circulation. (b)_____
(c) Prevent trapping of oil in the system. (c)_____
(d) Compensate for oversized suction lines. (d)_____

15. TRUE or FALSE Check valves are designed:
(a) To insure flow in one direction only. (a)_____
(b) For use with liquid refrigerant only. (b)_____
(c) For use with suction, hot gas & liquid. (c)_____

16. A "back pressure regulator" modulates the flow of liquid refrigerant to the evaporator in order to maintain a con stant pressure and temperature in the evaporator. TRUE or FALSE _____

17. A clear sight glass in the liquid line always indicates a full charge of refrigerant. TRUE or FALSE _____

18. TRUE or FALSE The purpose of a crankcase heater is to:
(a) Keep the crankcase oil thin. (a)_____
(b) Minimize accumulation of refrigerant in the crankcase during shutdown. (b)_____
(c) Control the compressor discharge gas temperature. (c)_____

19. TRUE or FALSE A liquid-suction heat exchanger installed in a refrigeration system usually results in which of the following?
(a) Superheating of suction gas. (a)_____
(b) Elimination of flash gas in the liquid line (b)_____
(c) Subcooling liquid refrigerant. (c)_____
(d) Assure better oil return. (d)_____

20. TRUE or FALSE A suction line accumulator when installed in a refrigeration system provides an intentional trap to collect oil and return it gradually to the compressor rather than in a slug which may cause damage. _____

21. TRUE or FALSE Extreme care must be exercised when sizing and locating a muffler in a refrigeration system. _____

22. Which of the following lines is usually considered the most critical in regards to size and layout? _____
(a) hot gas line
(b) condensate line
(c) liquid line
(d) suction line

23. A suction line is normally sized for a pressure drop equivalent to a _____degree F drop in saturated refrigerant temperature._____

24. When insufficient oil return is the problem, the suction line should be (INCREASED, DECREASED) in size to allow more oil to return. _____

25. There are two methods covered in this chapter of preventing refrigerant draining from the evaporator to the compressor during shutdown. Name them.
(1)_____
(2)_____

26. A hot gas line is usually sized for a pressure drop equivalent to _____ degrees F change in saturated refrigerant temperature.

27. When a compressor is located where its temperature will be lower than the temperature of the condenser during shutdown, refrigerant migration may take place. Name one method of preventing this

28. The evaporator in question requires 40 psig to function satisfactorily. The refrigerant is C Cl_2F_2 and pressure at the condenser is 126.8 psig. The TXV requires a 60 psig differential from high side pressure to low side pressure to function satisfactorily. The evaporator is 40 feet above the condenser. Will the equipment perform satisfactorily? Assume no line loss or accessory loss.

29. TRUE or FALSE Suction line insulation is used to prevent heat flow into the refrigerant.

30. The most common way that a system that was installed and built properly can acquire moisture is through_____.

31. When water is present in a halogenated hydrocarbon refrigerant system the first, and the most dangerous, product is_____?

32. Commercial C Cl_2F_2 should not contain more than____ P.P.M. of water.

33. In an air conditioning system without a sight glass, what would probably be the first indication of moisture ?_____

34. A moisture indicator is the best method of checking for moisture in the system. Assuming the indicator to be in good operating condition, what must you ascertain before checking the color?_____

35. TRUE or FALSE A vacuum of 5" hg absolute is a deeper vacuum than 20" of hg vacuum.

36. A ½" hg vacuum is equal to _____microns?

37. What is the lowest micron reading obtainable from a wet bulb indicator?

38. Assuming you do not have a vacuum pump capable of obtaining 100 microns, what two methods can you use to dehydrate by evacuation with a lesser pump?
(1)_____
(2)_____

39. One of the best system cleaning agents available to therefrigeration serviceman is _____?

40. You would normally expect to charge a 100 TR system using (GAS, LIQUID) refrigerant.

41. When a "suction service valve" is "backseated" it is turned all the way (IN, OUT).

42. TRUE or FALSE A "pinch off tube is a factory sealed tube and should never be broken.

NAME _____

43. TRUE or FALSE Facing the gauge manifold, the high pressure gauge should always be on the right. _____

44. When discharging refrigerant from the system into a sylinder, the low side manifold valve should be turned all the way (IN, OUT) and the high side manifold valve should be turned all the way (IN, OUT).
(1)_____
(2)_____

45. A serviceman charged by sightglass and started up an air conditioning unit in the early spring. About two months later he was called back because of "lack of capacity". He found sight glass bubbles but no leaks. What did he probably do wrong on the original start-up?_____
_____

46. "Weighing" a charge in is usually the best method of charging a new installation but it is not used too much in service work. Why not?

47. Though undercharging of refrigerants will usually cause a lack of capacity, it is more dangerous in that it can cause failures of hermetic motors. This motor failure is due to ____.

48. When refrigerant is "blown" or removed from a system too rapidly, what can result if the system has a water cooled condenser?

49. When placing major sycle components during installation what are the three main factors to be considered? (1)_____
(2)_____
(3)_____

50. TRUE or FALSE All compressors should be mounted on vibration isolators. _____

51. TRUE or FALSE Soft copper tubing is usually preferred because it can always be installed faster. _____

52. What may occur within copper tubing if it is subjected to large temperature changes?

53. Nitrogen has two general uses during installation. During what two installation procedures would you expect to find nitrogen being used?
(1)_____
(2)_____

NAME _____

54. Should a suction line with a temperature of 50° be insulated if the dew point of the room through which it passes never exceeds 45°? (consider insulation only to prevent condensation) _____

55. TRUE or FALSE A fused disconnect is required to break the electrical circuits to only high voltage load devices in the refrigeration system. _____

56. For a true leak test a pressure of approximately ____ psig is required. _____

57. TRUE or FALSE - Since the refrigeration installer does not have responsibility for electrical wiring or ductwork he should concentrate on his own work and not think about them. _____

58. The job is in operation and functioning satisfactorily. It has checked out as to capacity. What two things must you now do before that job can be considered complete? (1) _____

(2) _____

NAME: 388

Unit 23 - Quiz 5

Time:

Please do your best; you may not finish. Next week we will go over Exam and it will be returned. Next week we will also have a lab exam.

1. T. F. A unit with a 1 HP motor is often referred to as a One Ton unit.

2. T. F. There is a definite relationship between pressure and temperature of the refrigerant boiling point.

3. T. F. As back pressure decreases, compressor capacity decreases.

4. T. F. The greater the T D across the coil, the greater the Evap capacity.

5. T. F. A popular form of refrigerant metering device is the Evap. Press. Reg.

6. T. F. A pressure relief valve operates when the suction pressure gets too high.

7. T. F. An evap. fan not running increases suction pressure.

8. T. F. A dirty condenser causes hi head pressure.

9. T. F. A compressor unloader is often used on a system with a varying load.

10. T. F. An E. P. R. (Evap. press. reg.) maintains a constant condenser pressure.

11. The purpose of a "sight glass" is to

    a. watch boiling action
    b. check refrig. charge
    c. To monitor acid in the refrig.
    d. all of the above

12. A thermal expansion valve (TEV) is set to sense if the LP vapor at the evap. outlet is:

    a. superheated
    b. sub-cooled
    c. modulated
    d. liquified

13. A "high pressure cut out" control does what?

    a. by-passes hot gas into suction
    b. purges the system of air
    c. raises the head pressure
    d. shuts off the comp.

NAME:_____

14. A very loose TEV bulb on a frz. can result in

a. a starved coil
b. suction line frosting to comp.
c. low head pressure
d. low back pressure

15. If moisture frz. in a TEV, what can happen?

a. valve frz open
b. valve frz partially open
c. valve frz closed
d. possibly all of the above

16.&17. A Low side filter/dryer is usually located between the _____ and the _____.

18. On a Pressure Control the difference between the cut in and cut out is called the _____.

19. To compensate for excessive pressure drop in a evap. a TEV is often equipped with a _____.

20. A shell placed in a suction line for separating liquid refrig. entrained in suction gas from harming a Comp. is called a _____.

21. An apparatus in which heat is exchanged from the liquid line and the suction Line is called a _____.

22. The parts of a refrig. system under evaporator refrigerant pressure are called the _____.

23. Loss in pressure from an evaporator to the compressor is called _____.

24. Commercial low temperature cases lose temp. as _____ accumulates on the fins.

25. On a unit with a remote condenser winter problems can be caused by _____ head press.

26. A head press control valve controls head press by _____ hot gas into the receiver.

NAME: _____

27. Condenser capacity with a head press control valve is controled by _____.

28. In order to keep a comp. on line when suction pressure goes down, we can install a _____ to increase the load.

29. When frost blocks the fins air flow _____.

30. With a head pressure control valve, a rule of thumb is to do what to the refrig. charge.

a. double it
b. cut it in half
c. leave it alone
d. change it to R22

31. Which requires more heat sil flos or 95/5 solder? _____

32. To keep internal valve parts protected during soldering or brazing, wrap the valve with a _____.

33. T. F. The same flux is used for soft solder and silver solder.

34. T. F. Sil flos requires flux for copper to copper brazing.

35.&36. Oil pressure controls operate on differential between _____ press and _____ press.

37. Most oil pressure controls operate on manual, auto, time delay reset.(circle one)

38. On medium temp. units a common source of leaks is at the _____ flare nut because of expansion and contraction.

39. The most common and cheapest form of capacity control is to do what to the compressor.

40. If a comp stalls after defrost or on start up due to high back pressure, what control can be installed? _____.

41. To decrease the amount of oil circulating in the system we can install an _____.

NAME _____

42, 43, 44. A muffler may be installed in the _____ line to decrease _____ and/or _____.

45. T. F. A low temp and high temp compressor can be interchanged if the refrig is the same.

46. An internal O.L. is located where in a compressor? _____

47.&48. A klixon attached to comp housing usually operates on either _____ or _____.

49. Refrig migrates to the colder/warmer areas. (circle one)

50. How do you reverse directions of a three phase motor?

_____

_____

51. How do you determine a grounded comp?

_____

_____

52. T. F. A recripocating comp should pull down at least to 10 " Vac.

53. Suction Line pressure drop decreases/increases system efficiency. (circle one)

54. When changing a B.O. Comp. manufacturers do not recommend using the new comp as a _____.

55. Phos gene gas is formed by _____.

56. Phos gene gas is/is not dangerous. (circle one)

57. T. F. In a severe burn out the refrig should be discharged.

58. When changing a comp or TEV you should also change the _____.

NAME _____

59. T. F. If nitrogen is not available oxygen can be used safely to pressurize a system.

60. Why should a refrig drum not be filled to the top? _____

_____

61. Using a amphrobe, fuses can be checked by pulling the fuses and checking _____.

62. What would you do if suction press is extremely low but there is liquid at the inlet to the TEV? _____

63. What could be wrong if head press is high but the liquid line and most of the cond is cool? _____

64. To prevent short cycling on the LP control some mfg install a _____ .

65. A three phase unit starts when the _____pulls in.

66. T. F. A water valve opens more on a raise in head pressure.

67. In order to save on heat costs in the winter what can you do to recover refrig. Cond heat?

_____

68. On our field trip we saw that upright frz. use two or more streams of air in order to _____

_____

69. Dual Voltage motors are often carried in a service truck because _____

_____

NAME _____

70. Describe a straight time defrost.

71. Describe time pressure defrost.

72. Describe an off cycle defrost (defrost cycle).

73. The instrument used to check amp draw with a "clamp on" is commonly called a _____.

74. Comp unloading can be provided by holding open the _____ _____ valve by mechanical or other means.

75. The primary problem of connecting two parallel compressors to a single system is usually _____.

76. T. F. A water tower operates more efficiently on a humid day.

77. When starting a unit on a hot day when head press is too high you can lower head press by doing what to the comp? _____

_____.

78. Why is a pressure limiting TEV used?_____

79. During normal operation the compressor service valves are

a. back seated
b. cracked
c. front seated
d. none of the above

NAME: _____

80. The safest way to charge a commercial unit is to dump Liq. Refrig. in the

a. liquid line
b. evap
c. comp
d. none of the above

81. T. F. On a Time Press. Time clock with a 90 min. fail-safe the defrost can be shorter than 90 min but no longer.

82. Comp. mfg allow for a _____% increase or decrease over rated amps.

83. A contactor with elec. O.L. devices to de-energize the circuit is called a _____.

84. A sight glass often has a _____ indicator built in.

85. On a pump down system, short cycling usually means leaking _____.

86. Refrig tubing is usually type _____ in the suburbs.

87. A normal length of refrig tubing is _____ feet.

88. When measuring diameter of refrig tubing, we measure I.D./O.D.? (circle one)

89. When joining steel to copper what types of joints should be used on refrig discharge lines?

a. 95/5 solder
b. 50/50 solder
c. sil-fos 15
d. silver solder 50%

90. On a storage frz. a fan delay after defrost is used to _____

_____

91. T. F. Most servicemen don't mind changing valve plates on a semi-hermetic because the gaskets come off easily.

NAME:_____

92. With the comp off, if the suction valve is front seated and press raises rapidly, it may mean _____.

93. How can we tell at the unit what type of refrig is in the system if it is not marked?_____

94. The color of a R12 refrig drum is _____. R22 drum is _____.

95. A leak detector torch is called a _____.

96. T. F. A common problem in ordering motors is determining which rotation to order. (i.e. is it shaft or opposite shaft end)

97. When a case cooler or AC. drain is plugged the quickest way to unblock it is to _____.

98. T. F. On a water cooled unit the liquid line is warmer than the leaving water.

99. How should contaminated comp oil from a badly B.O. Comp. be handled?

_____

100. On an air handler if the motor amps are high when the blower cover is off, it could be because _____

_____

101. On a remote cond. with a head press reg, if the head press is low and the Liq. drain line to the receiver is cold we should

a. adj TEV to 10° superheat
b. check comp efficiency
c. add refrig
d. change or adj regulator

NAME:_____

102, 103, 104. Name 3 possible reasons for a unit with a water cooled Condenser to cycle on Hi Head Pressure?

_____

_____

_____

_____

105. If a beer cooler L.P. control is set to cut in at 36# (R12) and the suction press is 45# (comp not running) how would you check the control?

106. The temperature of the Medium being cooled must be

a. below evap temp
b. equal to evap temp
c. above evap temp
d. below freezing

107. T. F. A refrigeration technician should remember he is a skilled professional. He conducts himself in a business-like manner.

108. Explain the counter flow principle on a water cooled condenser.

_____

_____

_____

_____

109. How does Wet bulb temp effect an evaporative Condenser? Relate this to head pressure.

110. T. F. A TEV with a distributor must have an external pressure equalizer.

NAME: _____

111. On a water tower, why is a water bleed off required?

_____

_____

_____

112. To save good refrigerant to be removed from a system, what can we do to the refrigerant containers to facilitate refrig. flow.

_____

_____

_____

113. How does an Evaporative Condenser <u>differ</u> from a water tower?

_____

_____

_____

114. On a motor with a "Name plate rating" of 10A and a 1.2 safety factors, what is the Max. allowed amp draw? _____

115. T. F. A Refrigerant container or receiver can be filled to 95% capacity safely.

116. T. F. All commercial units are wired so that when the Compressor disconnect is off, it is safe to handle wires at the Compressor.

117. Describe a fusable plug; what are the disadvantages of its use?

_____

_____

_____

NAME:_____

118. Why is an Automatic water regulating valve used on a Water Cooled Condenser using city water?

_____

_____

_____

119. Describe how you can control temperature using a solonoid valve?

_____

_____

_____

_____

120. On a roof top mounted AC unit why is a crankcase heater used?

121. Describe a water chiller unit.

_____

_____

_____

_____

122. Why do we have a heater wrapped on the water condensate drain line on the Low temp frz in the lab?

123. What could be the problem if the dryer is sweating?

_____

_____

NAME:_____

124. How is sweating prevented on freezer doors?

125. What are two economical means of controling head pressure on an Air Conditioner unit operating in the spring or fall?

_____

_____

_____

126. What is the purpose of an oil safety control?

_____

_____

_____

127. Why is a frz out control used on a water chiller unit?

128. Why are fins on a frz case coil spaced more widely at the return air intake (warmest air)?

129. If you get this far, Good! Write"one free point" here._____

130. Comments on course, tests, lab, etc.

_____

_____

_____

_____

AREA - BACKUP HEATING SYSTEM

Unit 24 - Electric and Heat Pump Systems

I. Instructional Objectives
Student will be provided with a working knowledge of the operation and service procedures involved in resistance and heat pump heating.

II. Reference Materials
Comfort Heating, 7, 10
Carrier GTA - Electric Resistance Heating and Heat Pump
Basic Heating with Electricity
Honeywell-Electric Heating

III. Visual Aids
Honeywell Overheads - Electric Heating
Carrier - GTA Slides, Heat Pump and Electric Heating

IV. Method Performance Conditions
Given electric resistance heaters and furnaces with all controls, different makes and models of heat pumps.

V. Outline

1. Familiarization with different types of electric heating with emphasis on efficiency.
2. Theory of operation of electric furnaces.
3. Installation and servicing problems encountered with electric furnaces.
4. Heat pumps
   A. advantages
   B. disadvantages
   C. operating characteristics
5. Reversing valves and defrost mechanisms used in heat pumps
6. Trouble shooting heat pumps and related control systems.
7. Electric boilers
   A. advantages
   B. limitations
8. Analysis of electric hydronic systems and accessories

9. Troubleshooting

   A. Electric hydronic controls

   B. Control systems

10. Problems encountered

   A. Radiant panel electric heating

   B. Line voltage thermostats

VI. Student Evaluation Parameters

Student will demonstrate understanding of differences between electrical heating and other forms. Student will size, install, service electric resistance furnaces and heat pump systems.

VII. Sequence of Instruction:

1. Read all reference materials.

2. View visual aids.

3. Discuss electric and heat pump heating uniqueness.

4. Go over service, sizing, installation procedures.

5. Do lab assignments.

6. Take Unit tests.

Unit 24 - Sample Lab

Objective: selecting equipment

Needed: house floor plan and specs

Procedure: using chapter 3 in book, figure heat loss for print of house.

Procedure:

1. Actual glass for each room is given in ventilation schedule.
2. Windows are double 3/4" air space.
3. Doors are solid, 1 3/8 with storm.
4. Walls are frame - wood siding inside is lath, plaster and 3 5/8 insulation.
5. Basement 8" concrete 2' above grade.
6. Ceiling - lath and plaster 6" insulation.
7. Outside design temp. is -10 degrees.

Size the house and select the heater for each room. Use back of this sheet. Set up like form on page 34 of book.

Name_____

Unit 24 - Sample Lab

Objective- To familiarize student with use of different formulas, terms, equipment components and meter use.

Materials Needed-
Electric furnace
Resistence heat Coil
Simpson 260 meter and leads
Tool box

Project

1) Using formula from book find BTU output of one furnace and one resistence coil. Also using formula find watts for each.

2) Using formula find mean or average temp for a day when the max temp was 20° and the minimum was -20°

3) With Simpson meter check all components in electric furnace for short, grounded, open circuits.

   Write down each component check and wether good or bad.

Unit 24 - Quiz #1

1. Heating comfort is based on maintaining a constant ratio of body heat loss to body heat production. The body transfers heat to the surrounding environment in three ways. (choose three)
   a. convection
   b. direct contact
   c. radiation
   d. evaporation
   e. condensation

2. Within certain limits the body can adjust its heat production to match the rate of heat loss, without the individual being aware of any discomfort. The body does this by (choose one)
   a. consumption of more food
   b. sweating
   c. radiation
   d. changing the surface temperature of the body
   e. none of the above

or F 3. Evaporation of perspiration helps cool the body. This is because a great deal of heat must be added to convert a liquid to a gas, and some of this heat is absorbed from the skin.

Air movement, air temperature, radiant temperature, and relative humidity affect heating comfort. Show which methods of heat are affected by each factor. Questions 4, 5, 6. Choose any that apply.
   a. air movement
   b. radiant temperature
   c. air temperature
   d. humidity
   e. none of the above

or F 7. Cold wall effect, refers to the body's gain of heat by radiation to a cold surface nearby.

or F 8. An exhaust fan acts to draw outdoor air into the house. The cold outdoor air is warmed, thereby decreasing its relative humidity.

9. What is the main reason for locating baseboard convectors or registors along the outside walls of the house? (choose one)
   a. better furniture arrangement
   b. ease of wiring
   c. to offset cold wall effect
   d. more attractive for sales
   e. none of the above

10. In a radiant heat application using ceiling cable, a large part of the total heat input is delivered by the floor and other horizontal surfaces by (choose one)
   a. radiation
   b. convection
   c. evaporation
   d. reflection
   e. all of the above

or F 11. In combustion heating, the burner releases "stored" energy and must dispose of the waste products. In electric heat, there is no residue.

or F 12. An atom that is electrically balanced has an equal number of protons and electrons.

The Ohm's Law triangle shows a correct relationship of three factors of electricity. Fill in the three sections.

13. Upper triangle section
14. Lower Left
15. Lower Right

a. watts
b. current
c. amperage
d. resistance
e. voltage

16. How many volts are used in pushing a current of 12 amps through 100 ft. of No. 14 copper wire (resistance ½ ohm)? (choose one)
    a. 9 volts
    b. 12 volts
    c. 3 volts
    d. 4 volts
    e. none of the above

17. The amount of voltage that is expended in moving current through a resistance is called the (choose one)
    a. voltage drop
    b. voltage surge
    c. voltage times current
    d. wattage
    e. name of above

18. Convert 200 watts to Btuh.
    a. 640
    b. 900
    c. 1000
    d. 2000
    e. none of the above

19. Convert 100000 Btuh to watts.
    a. 1
    b. 509
    c. 2930
    d. 3250
    e. none of the above

or F 20. The amount of heat produced by a current passing through a resistance is determined by the formula $W=I^2R$.

21. Name at least two qualities of a good heating resistor.
    a. metal
    b. high resistance per unit length
    c. durability
    d. conducts heat
    e. stability at operating temperatures

22. In a series/parallel circuit, the current is the same through all parts of the circuit. In a series/parallel circuit, the total voltage applied to the circuit equals the sum of the voltage drops across the individual resistances. Indicate the correct words below:
    a. series
    b. parallel

T or F 23. Line voltage is the household use voltage (110-220)
Low voltage is less than 30 volts (usually 24 volts nominal)

24. What three pieces of information will appear on the nameplate of a transformer?
a. wattage
b. VA rating
c. primary voltage
d. resistance
e. secondary voltage

T or F 25. The VA rating tells us how large a load the transformer can handle.

26. The thermostat
27. The switching relay
28. the limit control

a. cuts off power in event of over-heating
b. senses room temperature and signals heating equipment
c. switches control to limit
d. switches electrical loads beyond capacity of thermostat
e. none of the above

T or F 29. Response time refers to the amount of time required for heating equipment to reach operating temperature.

T or F 30. The heavier currents carried by line voltage thermostats require lighter switching devices.

T or F 31. With a series connected heat anticipator, the heat produced will remain the same regardless of the load. With a parallel connected anticipator, the heat produced will vary with the load.

T or F 32. Line voltage thermostats use adjustable heat anticipators.

T or F 33. Heat anticipation increses the cycling rate. (increase control accuracy)

34. One of the problems of magnetic switching relays is the noise they make during operation. How is this noise usually damped?
a. using very large contacts
b. using an oil filled power head
c. remoting the relay
d. using heavy return springs
e. all of the above

35. All switching relays used in electric heat applications should be snap acting to avoid problems such as (choose one)
a. current delay
b. excessive current surges
c. burned contacts
d. overloads
e. none of the above

T or F 36. If a linear limit "Fails Safe", it shuts off the power to the heater. If the sensing element springs a leak and loses pressure.

T or F 37. Relays are cascaded by wiring them so that one relay will energize its load and the next relay in line.

T or F 38. Two reasons why ceiling cable heat is usually installed in new homes at time of construction is becuase extra insulation is installed in the ceiling above the cable and the cable is installed above the finished ceiling.

T or F 39. Why doesn't ceiling cable require any limit protection? (choose one)
a. built into cables
b. short would cause no damage
c. operates at low temperatures
d. too dangerous
e. none of the above

40. Why is electric heating so efficient? (choose one)
a. one BTU of electrical energy used produces two BTU's of heat
b. when 5 BTU's of energy are used, no current surge is seen
c. resistance heating is good for humidity
d. no particular advantage in efficiency
e. one BTU of electrical energy used produces one BTU of heat

T or F 41. Electric heat is beneficial from an ecology standpoint because used to produce electricity is burned in one remote area.

42. When considering electric heat what factors should be looked into. (choose one)
a. higher electric bills
b. higher construction costs
c. extra wiring required
d. more insulation needed
e. all of the above

43. What are three facets of electric heating
a. resistance heating
b. inductance heating
c. reactance heating
d. heat pump
e. heat pump, and resistance combined

T or F 44. Resistance heating use a centrally heated medium.

T or F 45. Resistance wire for heating purposes is made of high nickel copper alloy.

46. What material is used in repairing the broken resistance wire. (choose one)
a. solder
b. flux
c. welding rod
d. borax
e. none of the above

T or F 47. Resistance elements are located directly in the air stream inside the furnace.

48. How is each element protected from overheating. Choose any that apply.
a. main line fuses
b. fusible link
c. limit switch
d. manual switch
e. voltage regulator

T or F 49. An enclosed element is used in a basement type of heater.

50. What is the nickel content of the resistance wire?
a. 99%
b. 80%
c. 50%
d. 20%
e. 5%

T or F 51. The maximum watt density per square inch of duct area for duct heaters is 156 watts.

52. Which type of coil is recommended for most space heating application
a. open
b. enclosed
c. infrared
d. modular
e. radiant

T or F 53. 1000 watts = 1 kilowatt

T or F 54. Watts x 3.413 = BTU/hr.

T or F 55. Degree days is a term which indicates the severity of a winter.

T or F 56. Heat load calculation for electric heat is just like any other heat.

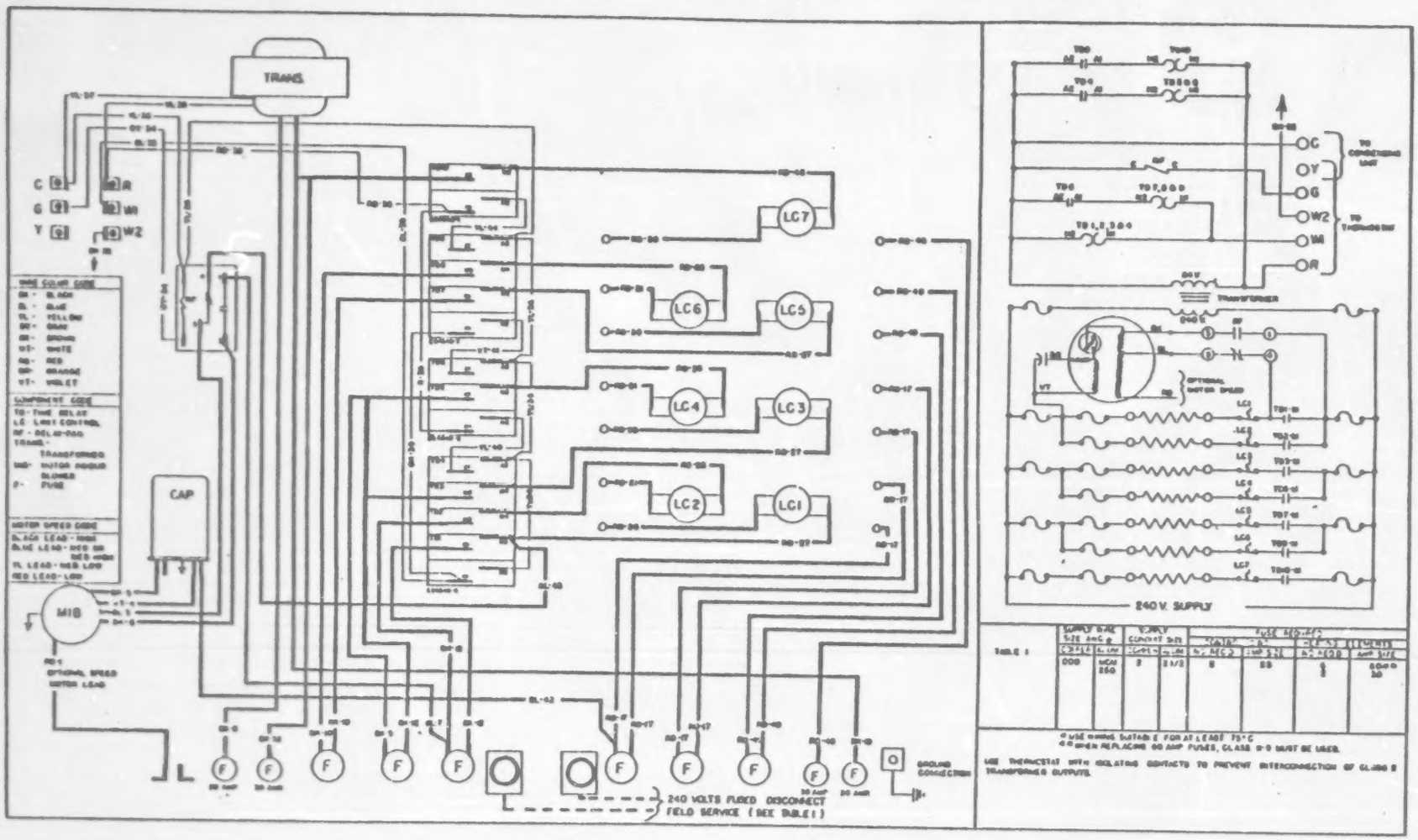
57. What are good places to insulate a house. (choose any that apply)
a. dormers
b. wall between heated and unheated areas
c. attics or roofs
d. floors over unheated areas
e. perimeter of slabs

T or F 58. A variable heat anticipator functions in the same manner as a fixed heat anticipator.

T or F 59. A terminal relay is a type of sequencing control.

T or F 60. The sequence-on, sequence-off relay configuration is the most used in the Amana furnace.

61. Check the following wiring diagram. Will this system operate properly if a low voltage connection to a thermostat was made. Follow all wiring. Is it wired correctly? (If not, correct it.)


TRANS
CAP
MTR
LC7
LC6
LC5
LC4
LC3
LC2
LC1
240 VOLTS FUSED DISCONNECT
FIELD SERVICE (SEE TABLE I)
GROUND CONNECTION
240 V. SUPPLY
TRANSFORMER
TO CONDENSING UNIT
TO THERMOSTAT

409

Name 410

Unit 24 - Quiz #2

True or False

_____ 1) Resistance heating elements operate at 100% efficiency.

_____ 2) A resistance heater rated at 240V that is connected to 208V power source will deliver only 75% of the nominal rated kw, but is still 100% efficient.

_____ 3) The term heat pump denotes a year-round air-conditioning system that utilizes refrigeration.

_____ 4) Space is saved by using a heat pump.

_____ 5) A single source of power supplies both heating and cooling requirements.

_____ 6) Heat output in BTU is approximately two to three times that of the purchased energy input in BTU.

_____ 7) Building costs are lower, no chimney required.

_____ 8) No potential fire hazard from open flames.

_____ 9) No changes are made when figuring heat gain and loss (electric verses gas.)

_____10) Supply temperatures in heat mode are moderate.

_____11) Preventive maintenance is essential.

_____12) If outdoor temperature goes below the balance point the compressor will run all the time.

_____13) Customers will sometimes complain of steam or smoke coming from the outdoor unit. This is caused by (choose one of the following)

a) Electric Phase changes.

b) Snow on the equipment.

c) Too high of outdoor temps.

d) Unit going through defrost cycle.

e) None of the above.

_____14) There is some heat in air all the way to absolute zero, 459.69° below.

_____15) A 3 ton air conditioner must reject 54,400 BTU of heat.

_____16) A 3 ton air conditioner can heat the indoors and deliver 40,000 BTU indoor heat.

_____17) Electrical input to a unit is wasted heat in cooling, while on heating cycle it becomes usable heat.

_____18) Any split system heat pump uses two metering devices and two check valves.

_____19) The main difference between heating and cooling cycle is refrigerent flow direction is changed.

_____20) The main flow direction is changed in the compressor by use of a reversing valve.

Match the formula and cost with the type of heat. Assume oil costs .45¢ per gallon
Assume gas costs .30¢ per 100 cu. ft.
Assume electricity costs .03¢ per kwh.

_____21) Heat pump delivering 39,000 BTU's.

_____22) Electric Resistance heat.

_____23) Oil heat 75% efficiency.

_____24) Natural Gas 75 % efficiency.

a) 39,000 BTU/h @ 5.6 kw
5.6 kw X 0.03¢/kwh = 16,8¢ hour

b) $\frac{39,000}{140,000 \times .75}$ = 52 cu. ft ∠ 0.30¢/ 100 cu. ft. = 15.6¢ hour.

c) $\frac{39,000}{140,000 \times .75}$ = 0.37 gal X .45¢/gal = 16.7¢ hr.

d) $\frac{39,000}{3412}$ = 11.43 kw X 0.03¢/kwh = 34.2¢/hr.

e) $\frac{39,000}{140,000X.75}$ = (cu.ft.)or(gal) X .30¢/(100cu.ft.)or(gal.)=18.2¢hr.

_____25) Outdoor thermostats should be used to operate back up resistance heaters.

_____26) Equipment selection for a job should be determined by (choose any that apply):

a) Load calculation cooling and heating
b) Equipment Rating
c) Performance curves
d) Air flow capabilites of equipment
e) Duct sizing and lay out

_____27) Equipment location outdoor is determined by (choose any that apply):

a) Unrestricted air flow
b) Protection from prevailing winds
c) Provisions for drainage
d) Accessibility for service
e) Distance between indoor and outdoor unit

_____28) Equipment location indoor is determined by (choose any that apply):

a) Centeralized location
b) Proximity of power supply
c) Assessibility for service
d) Consideration for routing of ref. tubing
e) None of the above

29) The most common air system problem is clogged or dirty filters.

30) What is the heating value of a furnace whose number is 40ES420300? 30KW?

31) A unit with 21KW capacity must have two separate power supplies.

32) The sequencer provides a nominal time delay of 30 seconds between heater starts.

33) You answer a complaint of "NO HEAT" and find the fusible link has blown on the resistence heater coil. You should check the limit switch and the air flow.

34) You want to determine the unit CFM using the temperature rise method. You would get entering and leaving air temps,plusvoltage and amperage.

35) When measuring the leaving air temperature it is important to position the thermometer where it will not "see" the heater elements.

36) .How would you go about measuring the current on a unit having two separate power supplies? Measure the amps at both supplies and add the readings?

The next page of this test is a wiring schematic of a BARD heat pump

The system is in normal condition (nothing calling)

Correct any wiring or switching you feel is incorrect.

Circle any and all corrections.

After determining correctness of wiring schematic, give a step-by-step procedure of events that would follow closing of CoolSwitch, and C1 thermostat. List all relay coils that would energize, all contacts that would close, and how they would do so.

Unit 24 - Quiz #3

Name_____

Date_____

1. What part of the heat pump is arranged to pick up heat from air, water, etc.?

2. What is temperature?

3. What two kinds of pressures are of interest in refrigeration?

4. What determines the temperature at which refrigerant evaporates in mechanical refrigeration?

5. What does the capacity of a refrigeration system depend on?

6. Where does the heat necessary to cause liquid to change to vapor come from?

7. Where is the heat removed by the condenser usually transferred?

8. What is the primary advantage of a properly designed and installed heat pump system?

9. What does the body burn to produce heat?

10. If the heat is not rejected by the body as fast as it is produced, what happens?

11. When may a room be considered comfortable?

12. Name the four ways that the body gets rid of heat.

13. Explain the process of convection of heat.

14. What are the three main factors that affect the rate of body heat loss?

15. What happens to relative humidity in new tightly built homes?

16. What is the relative humidity range in which the comfort within a home is not seriously affected?

17. What is the purpose of check valves in the heat pump circuit?

18. What is perhaps the most economical heating device developed by man?

19. In what ways can heat escape from a building?

20. Is there any difference between the way heat is lost or gained in a building?

21. When is temperature difference greater, during heating or cooling?

22. What is the average t.d. during heating?

23. Is the heat loss in basement floors more than floors and walls at ground level?

24. At what depth of ground does the temperature stabilize?

25. Is the insulation around the edge of a slab floor more effective in winter or summer?

26. What does the "R" value of insulation indicate?

27. Where is insulation placed for a slab on grade?

28. What care should be given eave ventilation?

29. What is done to walls where there are pipes, ducts or electrical boxes?

30. What is recommended as a vapor barrier ground cover?

31. On what side of the insulation is the vapor barrier placed?

32. In Figure 1, if valves 1 and 4 are closed and valves 2 and 3 are open, what is the unit operating as?

33. What is the small cylinder attached to the solenoid coil (Fig. 4) called?

34. Through what does the discharge pressue bleed to relieve pressure on the desired valve end?

35. What metering device (Figure 7) is used during heating?

36. Why are the check valves used with the metering devices?

37. What type metering device is used in Figure 6?

38. What metering devices are shown in Figure 8?

39. What problem may arise if the condenser air is too cold?

40. What will result from dirty filters during heating?

41. What happens during heating cycle when the outdoor coil temperature drops below 32°F.?

42. Does frost on the outdoor coil indicate poor design?

43. A heat pump performs what functions?

44. What is the most common method of defrosting?

45. What happens to the air passing through the outdoor coil when frost begins to accumulate?

46. Could a head pressure control terminate defrost?

47. What function does the control in Figure 20 perform?

48. What controls the operation of the magnetic coil of Contactor "M" (Fig. 21)?

49. What happens to 3R coil when TM contacts open? (Fig. 23)

50. When is auxiliary heat normally added to heat pumps?

51. What actuates the auxiliary heat?

52. What is used to prevent auxiliary heaters from operating when compressor supplys enough heat?

53. How low should the outdoor thermostat be set?

54. At what temperature (Fig. 26) should auxiliary heaters be energized?

55. If the heat output of the heat pump is 45,000 BTU's at 70° outdoor temperature, what is the output at 10° outdoor temperature? (Fig. 26)

56. In Figure 28, what is the compressor discharge pressure?

57. What is the indoor 'return air temperature'? (Fig. 28)

58. In Figure 28, what is the evaporator pressure?

59. What type heat pumps are most commonly found?

60. What does C.O.P. mean?

61. How is C.O.P. determined?

62. What happens to the heat pump C.O.P. as the outdoor temperature drops.

63. What is the purpose of the suction line accumulator?

64. What is the only really new device in the heat pump refrigerant circuit?

65. What type of heat is normally used for supplementary heat?

66. How is the size and number of supplementary heaters determined?

67. What is the usual method of selecting the correct size heat pump for any job?

68. What is the most common method of controlling the use of auxilliary strip heat?

69. What does the first step of the room thermostat do?

70. Does air-to-air heat pump capacity increase or decrease as outdoor temperature drops?

71. How much more heat can be moved by a heat pump for each KW of electrical input compared to straight resistance heating?

72. How many BTUH are produced by 1 Kilowatt input to a resistance heater?

73. What will 1 KW input to a heat pump, operating at a COP of 2.5 produce in BTUH?

74. What is the point in outdoor temperature below which a heat pump will not provide sufficient heat called?

75. Where are the outdoor thermostats located?

76. At what voltage input are electric resistance heaters rated for full BTUH output?

77. What are several important factors to be considered before final selection of a heat pump's outdoor location?

78. Where anticipated snowfall is heavy, strong consideration should be given to what?

79. What is the function of a defrost relay?

80. What is the easiest and most accurate method of checking CFM on indoor coil with electric heat?

81. What measurements are required with the temperature rise method?

82. If 10 KW of electric heaters at 240 volts produces 34,1000 BTUH, what would the same heaters produce in BTUH at 208 volts?

83. What items should be given specific attention when instructing a heat pump owner?

84. What should be the capacity of a suction line accumulator?

85. What is the recommended method of evacuation?

86. What is the position of the outdoor check valve during the cooling cycle?

87. When does the indoor check valve open?

88. What is the remedy if a check valve is found sticking?

89. What activates the Sporlan 4-Way reversing valve?

90. Why can the reversing valve not be disassembled for installation?

91. What precaution should be taken when soldering a reversing valve?

92. How is the high pressure discharge gas allowed to build up on the ends of the main slide?

93. What causes slide position to change?

94. What happens to the outdoor fan during the defrost cycle?

95. Why is it necessary to bring on supplementary electric heat when the defrost relay makes?

96. What causes the defrost relay circuit to break?

97. When would the emergency heat switch be turned on to supply electric strip heat?

98. What does the outdoor coil do during the heating cycle?

99. What affect does a drop in outdoor temperature have upon the amount of heat that can be moved by the heat pump compressor?

100. How many BTU's equal one KW?

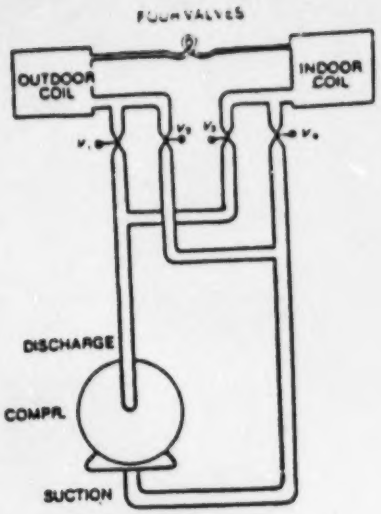


FIGURE 1

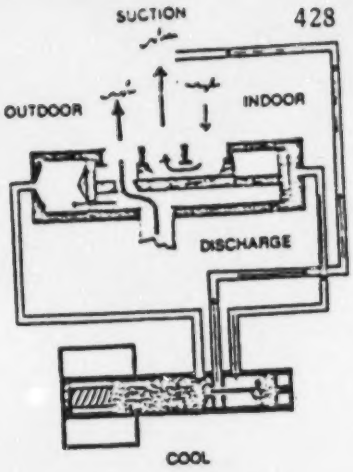


FIGURE 4

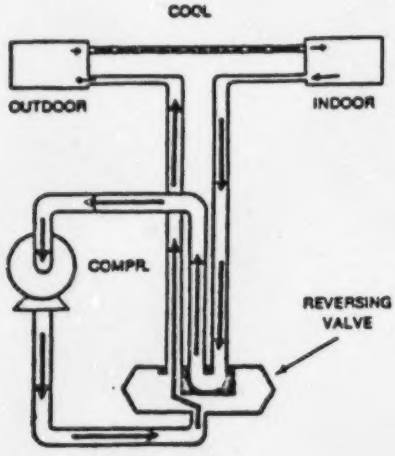


FIGURE 6

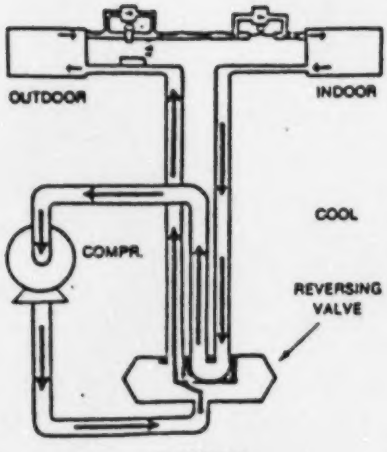


FIGURE 7

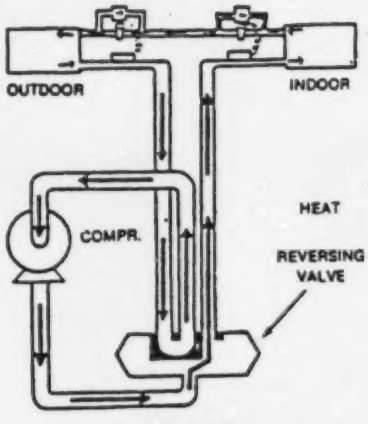


FIGURE 8

FIGURE 20

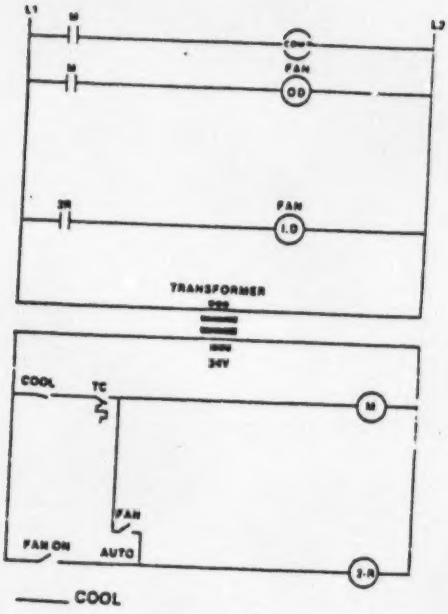


FIGURE 21

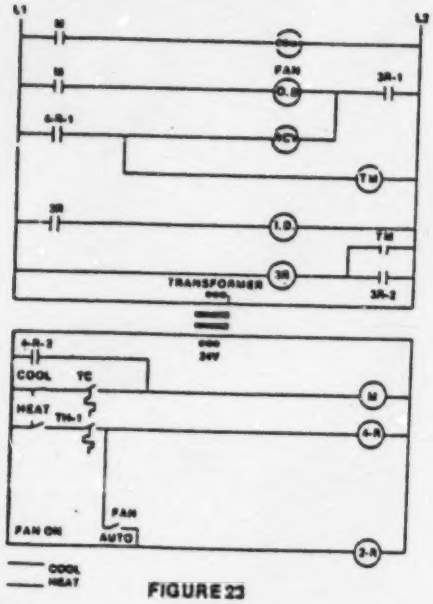


FIGURE 23

COOL CYCLE

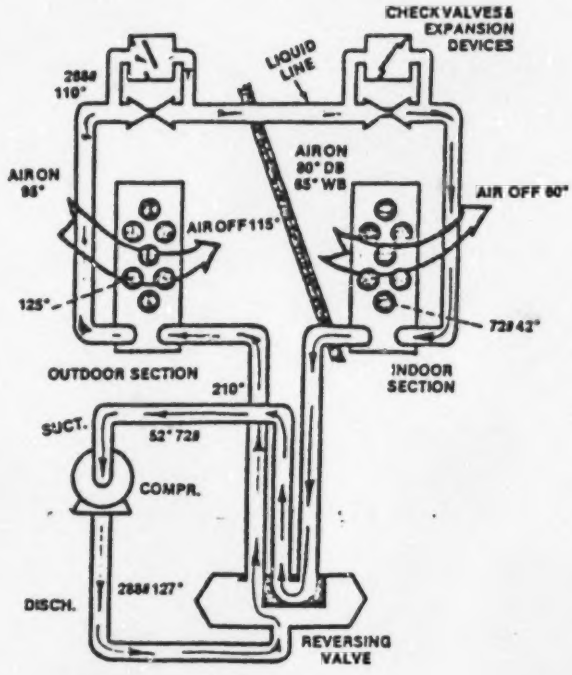


FIGURE 28

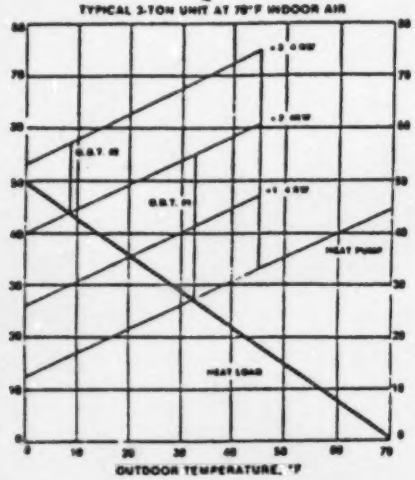


FIGURE 26

AREA - HEAT TRANSFER METHODS AND SYSTEMS

Unit 25 - Duct Work Design

I. Instructional Objective
To familiarize the student with various methods of duct sizing. Showing students how duct work is placed onto a set of blueprints. Show relationship between BTU's and CFM. Student will learn proper use of duct sizing calculators.

II. Reference Materials
ACCA Load Calculation Manual, D, K
Trane Air Conditioning Manual, 9
Carrier System Design Manual Air Distribution

III. Visual Aids
Carrier Air Distribution Filmstrip
Lennox Slides Duct Design

IV. Method Performance Conditions
Given work sheets and blueprints of house.

V. Outline

1. Familiarization with building construction and blueprints.
2. Comfort
   A. How the human body loses heat
   B. Importance of good design of heating and air conditioning systems
   C. Basics of heat flow through
      1. building walls
      2. windows
      3. ceilings
      4. floors
3. Infiltration and how to calculate it
4. Heat loss calculation work sheet
   A. Solar
   B. Latent
   C. Internal heat gains preparing for cooling load calculation procedure.
5. Comparative fuel costs and good venting methods.

6. History of warm air heating: 40 years of industry-sponsored research investigations at University of Illinois leading to development of design procedures.

7. Introduction to air flow patterns.

   A. ducts

   B. Measurement of pressures

   C. Resistances to air flow

8. Types of fans and fan performance.

9. Equal friction method of duct sizing.

10. Importance of selecting good fittings.

11. Methods of installation

12. Principles of continuous air circulation.

VI. Student Evaluation Parameters

Student will do sizing for heat loss/heat gain on structure assigned. Student will determine type of equipment and design of duct system applicable to blueprints. Student will place all air outlets and inlets, size duct and draw system into blueprint in form which shop foreman could make material list from.

VII. Sequence of Instruction

1. Read all reference materials.

2. View visual aids.

3. Go over blueprints reading.

4. Design system.

5. Unit test is turning in of completed project (design of duct system on blueprint) and exam.

Name_____

Unit 25 - Exam

Match the # question with a letter definition.

1) Primary air
2) Secondary air
3) Total air
4) Induction Ratio
5) Spread
6) Outlet Velocity
7) Temperature Differential
8) Induction
9) Throw
10) Drop

a) Mixture of primary air and secondary air

b) Average rate of air emerging from the opening.

c) Air drawn from the room into an outlet by primary air stream.

d) Air delivered to the outlet by the supply duct.

e) Divergence of the air stream in a horizontal or vertical plane.

ab) Air drawn or entrained into the air stream, discharged from the outlet.

ac) Horizontal or vertical axial distance an airstream travels.

ad) The total air divided by the primary air.

ae) Vertical distance the lower edge of a horizontally projected air stream drops between the outlet and the end of its throw.

bc) Temperature difference between primary air and room air.

T or F 11) Most complaints arising from faulty air distribution usually can be classified as Drafts, Stuffiness or Noise.

T or F 12) A comfortable room would have a three degree variation in temp and an air velocity of 100FPM

13) Good room air distribution should avoid: (Choose any that apply)

a) Temperature Stratification
b) Fluctuating gusts of air
c) Warm or Cold Spots
d) Localized high velocities
e) None of the above

14) There are basically three different types of Supply Air Outlets:

a) Ceiling Diffusers

b) Oval airators

c) Grills and Registers

d) Slot Diffusers

e) Extension grids

Match the Air Velocity (FPM) with the reaction an individual would have to these air flows.

15) 0-16 FPM

16) 25- FPM

17) 25-50FPM

18) 65- FPM

19) 75- FPM

20) 75-300FPM

_____ a) Complaints about stagnant air.

_____ b) Upper limit for people moving about slowly (dept. stores).

_____ c) Ideal design. Commercial applications.

_____ d) Favorable for some factory AC installations. High velocity, spot cooling.

_____ e) Probably favorable.

_____ ab) Unfavorable.Light papers blown off office desk.

T or F 21) A gage which utilizes the elevation of a column of water to measure temperature is called a manometer.

T or F 22) A gage connected to a tank of compresses air will indicate static pressure.

T or F 23) Total Pressure is the combination of Static and Centrifugal Pressure.

T or F 24) Air flowing through a piece of duct loses pressure due to internal static pressure.

T or F 25) Fans can be classified into two general catagories-- centrifugal or axial.

26) To select a fan to satisfy the proper conditions, three items must be known. (Select Three)

a) Air volume in cfm

b) Air volume in fpm

c) Fan Total Pressure

d) Air density

e) Fan Static Pressure

T or F 27) We now have two types of Duct design: High velocity and Low velocity, High velocity being the newer of the two.

T or F 28) When designing Duct work with the velocity method, an arbitrary velocity is assigned to each section of Duct work.

T or F 29) In using the Equal Friction method of Duct Design, the unit friction depends upon the allowable velocity.

T or F 30) Static Regain method of Duct sizing lets the velocity decrease along the ducts length.

AREA-HEAT TRANSFER METHODS AND SYSTEMS

Unit 26 - Sheet Metal Layout and Fabrication

I. Instructional Objective:
Student will be introduced to tools used in designing and assembling sheet metal. Student will be instructed in proper fitting layout and assembly procedures. Emphasis is placed on various types of seams, elbows and ducts, layout and fabrication, sealing of seams, triangulation, proper bench procedures. Emphasis is placed on various types of seams, elbows and ducts, layout and fabrication, sealing of seams, triangulation, and proper bench procedures. Student will learn how to draw all items before fabricating.

II. Reference Materials:
1. Precision Sheet Metal Shop Theory
2. Sheet Metal Practice
3. Sheet Metal Layout
4. Basic Sheet Metal Skills
5. Practical Layout for the Sheet Metal Shop
6. Air Conditioning Metal Layout
7. Sheet Metal Technology
8. Sheet Metal Shop Practice

III. Visual Aids:
1. Student guide sheet metal shop practices
2. Overheads of typical layout
3. Blackboard
4. Drawing board and tee square
5. 2 - (2H) pencils
6. 2 - (H) pencils
7. Pad 11x17 drawing paper - white
8. Architects scale
9. 2 Triangles (30°, 60°, 90°,) (45°, 90°)
10. 1 - Roll of masking tape
11. 2 - Erasers 1 - Pink Pearl 1 - Art Gum
12. Drawing set - compass and dividers

NOTE: SAFETY GLASSES WILL BE REQUIRED IN SHEET METAL SHOP

V. Outline:

1. Lap Rivet Seam — Plates 1,3,6,8
   Double Seam
   Grooved Team — Piece of duct 4"x4"x6"
   Pittsburgh Seam — Solder all seams

2. Drive Cleat — Plate 10
   "S" Cleat — Plate 11

3. 6" long piece of duct 4"x 4"x 6" w Drives & "S"

4. Square heel & throat El 90 Plate 14

5. Radius heel & throat El 45 Plate 19

6. Radius heel & throat El 90 Plate 16

7. Radius heel & throat 90 Change El Plate 17

Week 1	Introduction - Sylabus Homework Chapters 1 & 2 Ch. 1 - 3,5,7,19 Ch. 2 - 1-4
Week 2	Homework Chapters 4 & 15 Ch. 4 - 1,2,8,11,13,15,17,18,23 Ch. 15 - 1,3,8,10,23,25,29,35
Week 3	Fitting #1 due Homework Chapter 5 all questions
Week 4	#2 Due - Quiz #1 Homework Unit #1 all
Week 5	#3 Due Homework Unit #2 all
Week 6	MID-TERM Extra Shop Period
Week 7	#4 Due Homework Chapter #6 Odd questions
Week 8	#5 Due Homework Chapter #7 Even questions
Week 9	#6 Due Quiz #2 Homework Units 7-8-9 All questions
Week 10	#7 Due Review and Shop Time
Week 11	FINAL EXAM No Extra Shop Time

V. Outline (con't) Lecture Schedule

Week 1	Opportunities in Sheet Metal & Safe Work Practices
Week 2	Hand Tools & Soldering
Week 3	Layout and Patterns
Week 4	Measuring
Week 5	Layout Tools
Week 7	Care & Operation of Cutting Tools Snips & Shears
Week 8	The Squaring Shear
Week 9	Seams, Edges, Notabes & Fab
Week 10	Review
Week 11	FINAL

V. Outline (con't) Lecture Schedule

Week 1	Pattern Notching
	Simple Patterns
Week 2	Bending Brake
Week 3	Off Sets
Week 4	Slip - Roll Former
Week 5	MID-TERM
Week 6	Materials & Supplies
Week 7	Geometrics PT 1
Week 8	Geometrics PT 2
Week 9	Geometrics PT 2

V. Outline (con't) Fittings & Assignments

1.	Radius Off Set	Plate # 55
2.	Radius Change Off Set	Plate # 56
3.	Center Flare Transistions	(Hand Out)
4.	F.O.T. Change Transistion	Plate # 49
5.	F.O.S. Change Transistion	Plate # 50
6.	4 Side Transistion	Plate # 51
7.	"Y" Branch	Plate # 24
8.	Sq. - 2 - Rd. Center Flare	Plate # 66

Week 1	Intro - Syllabus	Chapter 8 Odd Questions Unit 10 all questions
Week 2	# 1 Due	Chapter 11 all questions
Week 3	# 2 Due	Unit # 12 all questions
Week 4	# 3 Due	Chapter 13 even questions
Week 5	# 4 Due	MID-TERM (Extra Shop)
Week 6	# 5 Due	Chapter 3 odd questions
Week 7	-	Unit # 3 and 4
Week 8	# 6 Due	Unit # 5 all questions
Week 9	# 7 Due	Unit # 6 all questions
Week 10	-	Extra Shop Time & Review
Week 11	#8 Due	FINAL (Rest of Period Make Up)

8	Drawings 12 pts ea.
8	Fittings 12 pts. ea.
10	Units or Chapters
	MID-TERM
	FINAL

V. OUTLINE (con't) Fitting and Assignments

1.	SQ.-2 - RD. on a 45 angle	Plate # 72
2.	Rectangular to Round	Plate # 69
3.	90 - Transition Elbow	Plate # 76
4.	90 - Change Transition Elbow	Plate # 78
5.	Transition "Y" Branch	Plate # 88
6.	Round Three - Piece Off Set	Plate # 106
7.	Round Two - Piece 45 Angle	Plate # 103
8.	Round Five - Piece 90 Riveted Elbow	Plate # 105

Week 1	Intro Syllabus		
Week 2	#1 Due	Unit #13	
Week 3	#2 Due	Chapter 19 questions	1 - 19
Week 4	#3 Due	Chapter 19 questions	20 - 38
Week 5	#4 Due	Chapter 21	1 - 17
Week 6	- -	MID-TERM	
Week 7	#5 Due	Chapter 21	8 - 13
Week 8	#6 Due	Unit # 14	all
Week 9	#7 Due		
Week 10	#8 Due		
Week 11		FINAL EXAM	

V. OUTLINE (con't)

Week 1	Plates	1	through	5
Week 2		6	"	11
Week 3		12	"	17
Week 4		18	"	23
Week 5		24	"	29
Week 6		30	"	35
Week 7		36	"	41
Week 8		46	"	51
Week 9	Make a Tool Tray			
Week 10				
Week 11				

VI. Student Evaluation Parameters:
Student will make assigned fittings and do assignments. Final evaluation will be the designing and construction of a small residential ventilation system tied into air solar system. All fitting ducts will be constructed, connected, and sealed properly.

VII. Sequence of Instruction:

1. Read assigned text
2. Review overheads
3. Do workbook assignments
4. Do lab projects as per outline
5. Take unit tests and take examinations in Sheet Metal Shop Practice workbook

UNIT 26 Quiz #1

1. Give a job opportunity available to someone having skill in sheet metal work. (List the responsibilities of a person in this job.)

2. What is a Scratch Awl and what are its uses.

3. What are Trammel Points and what are they used for.

4. What tool would have made the making of our Grooved Lock Seam alot easier.

5. Which of hammer is most commonly used by a Sheet Metal Worker.

   (a) Riveting
   (b) Setting
   (c) Nail
   (d) Raising
   (e) Ball peen

6. Why are Wooden Mallets important to use.

7. With a combination Blade Snip you can make both _____ and _____ cuts.

8. Aviation Snips are the main cutting tools used by Sheet Metal Workers today. (True or False)

9. A Press Brake is used for _____ _____ ?

10. Industrial eye injuries account for 5% of Workmen's Compensation cases. (True or False)

11. When handling sheet metal give four good rules to follow for safety.

12. What is the thickness of steel sheets measured in._____ numbers.

13. A Micrometer will determine the thickness of metal. (True or False)

14. Galvanized Sheet Metal is coated with _____.

15. The two methods of Galvenizing are, dipping the sheet and _____.

16. Electroplated Sheet Steel is distinguished by its gray color. (True or False)

17. Common widths of sheet metal are. (24" x38 x 48". (True or False)

18. Common lengths of sheet metal are 96" or 120"? (True or False)

19. The common type of stainless steel used in Sheet Metal Shops is # _____?

20. The great advantage of copper is its green color after aging? (True or False)

21. Sheet Aluminum is 100% Aluminum. (True or False)

22. Lead is used mostly today in our trade for _____.

23. When we say we have Angle Steel that is 2 x 2 x 1/4, what do the three measurements stand for.

24. What do we use Wire Cloth for.

25. Will the sheet metal worker have to ever handle piping or tubing? (Yes or No)

26. What is a Damper and what purpose does it serve.

NIT 26 Quiz #2

T F 1). Since the advent of the new welding techniques, riveted seams are not very common in modern sheet metal work.

T F 2). Blind rivets are so called because they may be installed completely from one side of the work.

T F 3). Bolt sizes are designated by diameter in fractions of an inch, number of threads per inch of length and length.

_____ 4). Another commonly used word for the blind rivet is the _____Rivet.

5). Explain what A 1/4 - 20 x 1 bolt means. _____
_____
_____

T F 6). Machine screws differ from small bolts in that they have slotted, recessed, or hexagonal heads.

T F 7). Machine screws may be driven from the head.

T F 8). The thread designation UNC stands for Unified Narrow Coarse.

T F 9). The thread designation UNF is also seen NF on blueprints specifications.

T F 10). The most commonly used bolt in sheet metal work is the 1/4 - 20 UNC bolt.

T F 11). Sheet metal screws are also called self-tapping screws because they tap their own mating threads.

T F 12). Most types of sheet metal screws are available with slotted, phillips and square heads.

T F 13). Self drilling screws have a tip like a drill bit.

T F 14). Nails are not commonly used as fastners in the sheet metal trades.

T F 15). A toggle bolt is used to fasten sheet metal to hollow surfaces.

T F 16). Star Dryvin expansion devices are used to fasten sheet metal to hollow surfaces.

T F 17). Lead screw anchors and plastic anchors are used in similar ways.

2.

T F 18). Lag expansion shields are used for very light construction.

T F 19). There is self-drilling snap-off ancor that speeds up fastening metal to solid concrete.

T F 20). Powder-activated fasteners are very dangerous to use.

21. Gas welding we use two gases. _____&_____.

T F 22). The main advantage of arc welding is that it is a compare-atively fast process.

T F 23). The most common types of inert gas welding is Tig & Mig _____ welding.

24). Another name for resistance welding is _____ _____welding.

25). In sheet metal work a _____ is a piece of material which is cut to the exact size and shape that the sheet metal must be cut.

T F 26). Templates are metal patterns that are used repeatedly.

T F 27). The term stretchout, refers to the distance across a round piece of pipe.

T F 28). The term Layout, refers to the method of developing the circumferences to develop square fittings.

T F 29). For complex items, a working or mechanical drawing is necessary to construct from.

T F 30). The mechanical drawing gives exact size and shape.

T F 31). Every break line should be prick punched.

T F 32). Notching and clipping are used to cut away metal to prevent overlapping.

T F 33). One of the first steps in layout, is to square the right end of the metal.

T F 34). Patterns are always located in the lower left hand corner of the sheet of metal.

T F 35). To read a circumference ruler, first you must determine the radius of the pipe to be made.

T F 36). The circumference is the distance across a circle.

3.

T F 37). To find the circumference of a piece of pipe, we multiply the diameter by 3.14.

38). What tool is a great help in making irregular curves in layout? _____.

39). Change the decimal .70 to a fraction which can be read on a common ruler. _____.

T F 40). The decimal .20 is commonly thought of as 1/4.

41). Find the circumference of a pipe that has a diameter of 5" .____.

T F 42). When cutting circles, one should trim excess metal before making the cut on the exact line.

T F 43). When cutting metal, it is not advisable to rest the blade and handle of the snips on the workbench.

T F 44). When cutting notches, keep the blades extended beyond the point where the notch will end.

T F 45). Oil your snips blades frequently.

T F 46). When cutting heavy gage pipe, both right and left handed snips are used.

T F 47). A nibbler is a hand tool used for cutting heavy metal.

T F 48). The bed of a squaring shear is what you lay your metal on.

T F 49). A squaring shear has a hold down for clamping metal in place.

T F 50). A compound lever shear can be used to cut large sheets of metal 12 gage or lighter.

UNIT 26 Quiz #3

1. A _____ _____ makes the duct work, which is connected to make up the entire system.

   a. fieldman
   b. heating man
   c. air conditioning man
   d. shopman

2. An _____ fastens or connects the various parts or pieces.

   a. model maker
   b. general sheet metal worker
   c. assembler
   d. shopman

3. Which of the following articles of clothing would <u>not</u> be acceptable in a Sheet Metal Shop?

   a. saftey glasses
   b. gloves
   c. shop apron
   d. long sleeve shirt

4. An electrical extension cord has three wires.

   a. White is power, black is ground, green is negative.
   b. Black is power, green is power, white is negative.
   c. White is power, black is negative, green is ground.

5. The normal operating position for a disconnected switch is:

   a. centered
   b. opened all the way
   c. closed
   d. on

6. According to your text what is the most common size sheet metal purchased?

   a. 48" X 96"
   b. 60" X 120"
   c. 36" X 96"
   d. 30' X 60'

7. 26 gauge is equal to which decimal thickness?

   a. .0281
   b. .0250
   c. .0219
   d. .0188

8. The fractional thickness of 20 gauge sheet metal is:

   a. 1/20
   b. 11/32
   c. 3/80
   d. 1/40

9. The _____ are pure metals that have not had another metal added to them.

   a. stainless steel
   b. alloy metal
   c. base metal
   d. aluminum

10. _____ steel has been processed more extensively than black sheet metal.

a. galvanized
b. aluminum
c. copper
d. cold-rolled

11. Copper is what percent copper and aluminum?

a. 79% copper, 21% alloy
b. 90% copper, 10% alloy
c. 99% copper,4% alloy
d. 100% copper

12. Most electronic communication chassis are made of:

a. stainless steel
b. copper
c. galvanized
d. aluminum

13. The most popular fastener you use today in the field is:

a. pop rivet
b. flat head hold.
c. Phillips recessed tap screw
d. pan head screw

14. The most popular marking tool used in sheet metal lay out is:

a. magic marker
b. crayon
c. scratch awl
d. center punch

15. The tool that tells you the stretch out of a circle is a:

a. common square
b. swing blade protractor
c. wing dividers
d. circumferance rule

16. Which tool would not be normally carried in a out side sheet metal mans tool box.

a. scratch awl
b. combination square
c. ruler
d. mallet

17. _____ are used to cut small curves and to cut straight 90^{o} inside corners.

a. combination snips
b. bull dog snips
c. pattern snips
d. aviation snips

18. Sheet metal tools require little or no maintenance, except for _____ after each use.

a. washing
b. oiling
c. sharpening
d. wiping

19. Between the numbers 5 & 6 on a steel rule how many divisions are there?

a. 16
b. 8
c. 4
d. 32

20. When using a scratch awl, you should:

a. Push the awl away from you.
b. Push it towards you.
c. Pull it towards you.
d. Pull it away from you.

21. Identify the following fraction, 7/16" in decimals.

a. .4375
b. .453125
c. .40625
d. .46875

22. When laying out a fitting what <u>one</u> view is most important?

a. isometric
b. top view
c. side view
d. bottom view

23. When using a squaring shear which materials can be safely cut with out chance of damaging the shear.

a. 16 ga. stainless
b. 24 ga. galvanized
c. 30 ga. wire
d. 1/16 wire rod

24. _____ is fastened to the cross head, which is moved by stepping on the treadle; it is used with the lower blade to cut the metal.

a. Cross head
b. Lower cutting blade
c. Upper cutting blade
d. Hold down

25. How many pieces can be cut at one time in your standard squaring shear?

a. one
b. two
c. three
d. four

26. A _____ is the portion of material that is cut out of a pattern before it is formed.

a. drive cleat
b. notch
c. "S" cleat
d. double seam

27. When making duct there is a notching tool which notches the material to a depth this depth is:

a. 1/2"
b. 3/4"
c. 13/16"
d. 15/16"

28. When you see B-UP-90° this is telling you which of the following:

a. Break the outside up 90°.
b. Break the inside up 90°.
c. Bow the side up 90°
d. None of the above.

29. Whitney hand punches can be purchased in a kit. The dyes necessary for almost every sheet metal man's need. How many dyes are there in the kit.

a. 5
b. 6
c. 7
d. 8

30. How many adjustments are there on a No. 5 Whitney hand punch.

a. 2
b. 3
c. 4
d. 5

31. This class meets on what day and for how many weeks?

a. Wednesday for twelve weeks.
b. Wednesday for eleven weeks.
c. Tuesdays for twelve weeks.
d. Thursdays for eleven weeks.

32. When laying out holes you lay them out:

a. inside to inside
b. inside to outside
c. outside to outside
d. center to center

33. When drilling, always make sure to grip the metal you are drilling firmly with a pair of vise grips.

a. true
b. false
c. I don't care
d. who cares

34. The sheet metal worker prefers to use a (an) _____ reading zig-zag rule.

a. circumference
b. common
c. retractable
d. inside

35 & 36. If the diameter of a circle is known, then the _____ can be determined with a (an) _____ rule.

a. radius
b. circumference
c. zigzag
d. swing blade

37. A tape rule can be used to measure the _____ of a cylinder.

a. circumference
b. height
c. width
d. raduis

38. The outside corner of a flat steel square is called the _____.

a. tongue
b. heel
c. blade
d. corner

39. Sheet metal fabricators are expected to be accurate to _____ in for measurements.

a. 1/32"
b. 1/16"
c. 1/8"
d. 1/4"

40. In sheet metal work, a _____ is seldom used.

a. protractor
b. steel rule
c. circumfrence rule
d. pipe wrench

41. A good line marker must _____ scribe a line on sheet metal surface.

a. temporarily
b. permanently
c. in black
d. etch

42. A (an) _____ is used to layout edge allowance for a 1/4 inch double seam.

a. marking gauge
b. common square
c. combination square
d. zig-zag rule

43. Very large arcs can be scribed on a sheet metal surface with a (an)_____.

a. Bow compass
b. trommel pts.
c. quick set dividers
d. Mickey mouse watch

44. The included angle on a center punch should be ground to:

a. 90^{o}
b. 180^{o}
c. 45^{o}
d. none of the above

45. The prick punch has a _____ point.

a. short
b. blunt
c. long
d. cylindrical

46. The difference between a prick punch and a center punch is the _____.

a. length
b. diameter
c. point
d. shape

47. The principal use of a cut list is to _____.

a. save time
b. save material
c. both time and material
d. make the fittings neater

48. "S" cleats are used to secure the ducts together after the drives have been installed.

a. true
b. false

49. "S" cleats are cut _____ in relation to the width of the duct or fitting.

a. 2" longer
b. 1" longer
c. 1" shorter
d. 1/4" shorter

50. The grooved lock seam is the most popular seam used in the sheet metal industry.

a. true b. false

51. The _____ is used almost only for fittings.

a. double seam c. pittsburgh seam
b. grooved seam d. rivet seam

52. The sheet metal trade is divided into how many divisions.

a. 2 c. 4
b. 3 d. 5

53. Sheet metal unions have one major draw back to non union shops.

a. wages c. working conditions
b. benefits d. dues

54. The cost of buying a journey man sheet metal workers card is:

a. 10 times the hourly wage c. $500
b. 100 times the hourly wage d. free for the asking

55. This course was designed to familiarize the student with_____.

a. basic hand tools c. basic seams
b. basic fittings d. all the above

56. When laying out an elbow the most time consuming portion should be _____.

a. measuring c. forming
b. cutting d. assembling

57. The most important people in a sheet metal company are the _____.

a. estimators c. supertendents
b. foreman d. workers

58. How many adjustments are on an easy edger machine?

a. 2 c. 3
b. 1 d. 4

59. When laying out a fitting, why is it important to leave one inch of straight on the side to be connected?

a. To insure that assembly of the fitting goes easily.
b. So the air straighten out before entering and leaving the fitting.
c. Ease of making the field connection.
d. So it looks neater.

60. Which of the following best depicts the ability most desirable for an average sheet metal worker.

a. The ability to understand and visualize fittings, and ducts.
b. The ability to measure and calculate what is to be needed.
c. The ability to design systems.
d. The ability to estimate jobs and co-ordinate the various stages.

UNIT 26 Quiz #4

DEVELOP THE LAYOUT NEEDED TO MAKE UP A PIECE OF DUCT THAT IS RECTANGULAR IN SHAPE 12" x 18". THE DUCT WILL BE 24" LONG WITH 1" LIPS TURNED 90° ON EACH END OF IT. THE 1" LIP WILL HAVE ½" TURNED COMPLETELY OVER TO MAKE A FINISHED 1" LIP EDGE. A PITTSBURG LOCKING SEAM WILL BE USED.

DRAW THE DUCT AS ONE PIECE OF METAL SHOWING ENTIRE LAYOUT, NOTCHING ALL MEASUREMENTS, ETC.

AREA - HEAT TRANSFER METHODS AND SYSTEMS

Unit 27 - Air Distribution-Balancing

I. Instructional Objective
Student will deal with various problems that can arise from systems that are not properly balanced. Student will learn various methods of air balancing.

II. Reference Materials
Trane Air Conditioning Manual 9
Carrier Air Balancing Manual

III. Visual Aids
Field trips to actual installations
Slide Carrier GTA Series on Air Balancing

IV. Method Performance Conditions
Given ventilation systems, anonometer, incline monometer, peto tubes, velometers, tachometers, incline monometers, and velocity meters.

V. Outline

1. Basic concepts
   A. Fluids
   B. Pressure (air)
2. Measurement of pressure instruments and their use in balancing.
3. Air flow through ducts.
4. Velocity changes due to design.
5. Horsepower vs. C.F.M.
6. Law governing fans.
7. Selecting the proper fan for the job.
8. Balancing the proper relationship between fan and duct size.
9. Cost saving with proper balancing.
10. Adjustments made during balancing.

VI. Student Evaluation Parameters

Student will show capability of using all air balancing meters and guides in balancing out an entire ventilation system.

VII. Sequence of Instruction

1. Read all assigned materials.
2. Discuss procedures of balancing
3. View all visual aids.
4. Do several small balancing practical paplications.
5. Final unit test will be total house air balance project.

AREA - HEAT TRANSFER METHODS AND SYSTEMS

Unit 28 - Hydronic Heating and Cooling

I. Instructional Objectives
Student will have knowledge of proper sizing techniques of hydronic heating and cooling systems. Selection of baseboard, pumps, proper controls. Student will know how to install and service hydronic system.

II. Reference Materials
IBR Design Manual
IBR H21 Manual
B & G Booster Pump Service Manual
SAM Manual Section 64

III. Visual Aids
Overheads made from installers guides.

IV. Method Performance Conditions
Given different makes and models of boilers, steam and hot water, convectors, baseboard, radiators, heat exchanger, control systems, solar water units.

V. Outline

1. Factors that affect comfort in heating and cooling. Method of calculating heat loss factors. Reference: "Why you feel hot or cold," H21 Guide.
2. Detailed method of calculating heat loss. Reference: H21 Guide.
3. Class project calculating a heat loss on the Hydronics Institute test house. Reference: H21 Guide.
4. Boilers, history, selection, accessory equipment. Reference 200 Guide, and a manufacturer's catalogue.
5. Heat distributing units: selection. Reference: 200 Guide, and a manufacturer's catalogue.
6. Hydronic accessory items: sizing, selection and application. Reference: 200 Guide, and manufacturer's catalogues.
7. Piping: sizing. Reference: 200 guide
8. Service
9. Steam systems: service, application. Reference: 200 Guide.
10. Commercial systems: how they differ from residential type systems.

11. Give student good working knowledge of how to service hydronic system effectively.

12. A. Boilers (hot water) gas and oil fired

1. how to field construct
2. packaged units available
3. servicing of their many components
   a. pumps
   b. zone valves
   c. air scoops
   d. expansion tanks
   e. three way valves
   f. aquastats

B. Boilers (steam) gas and oil fired

1. principle of operation pressure and vacuum
2. piping of same
3. water treatment
4. servicing of components

C. Boilers (electric)

1. servicing
2. maintaining

VI. Student Evaluation Parameters

Student will demonstrate knowledge of all hydronic components. Student will design, install, troubleshoot, maintain hydronic lab test units.

VII. Sequence of Instruction

1. Read all reference materials
2. Discuss and do sample sizings
3. View visual aids
4. Do lab projects in installation and servicing
5. Take unit tests.

Unit 28 - Quiz

1. How does water circulate in a gravity hot water system?

2. What is the heat emission rate in a gravity flow system?

3. How does gravity system respond to changes in outside weather conditions?

4. What is the modern forced circulation designed for?

5. What are the advantages of forced circulation?

6. How does pipe sizing for forced circulation compare with gravity system?

7. What causes pressure drop in a pipe?

8. Why is information regarding pressure drop important?

9. In what units do manufacturers furnish data for pressure drop?

10. One lb. per square inch equals how many feet of water?

11. One foot of water equals how many milliinches?

12. How does the term "head pressure" relate to "pressure drop"?

13. What is meant by the term "maximum head" of a pump?

14. Is "static pressure" the same as "head pressure"?

15. What is the effect of static pressure on pump capacity?

16. What will be the static pressure in a system where the highest radiator is 20' above the boiler?

17. Where should the static pressure of a system be read?

18. What is recommended to assure good flow in the top radiator?

19. Describe how a two pipe direct return system operates.

20. What is the disadvantage of a two pipe direct return system?

21. How does a two pipe "reverse return" system operate?

22. Describe the "series loop" system.

23. How does "monoflo system" operate?

24. Describe a radiant panel heating system.

25. What precaution must be taken in a radiant panel heating system?

26. Why is it necessary to provide an air cushion tank in a hot water system?

27. What is meant by "average or design water temperatures?"

28. Is it necessary for the system to operate at design temperature at all times?

29. Can a hot water system be designed for temperatures above 212°F.?

30. What is the effect on output when water temperature is raised from 170°F. to 215°F.?